

CATASTROPHIC RISKS AND MITIGATION MEASURES
AROUND THE WORLD

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ABSTRACT

Much attention is being paid to the topic of natural disasters with recent floods in Iowa, the deadly Sichuan Earthquake in China, and the horrendous Cyclone Nargis in Myanmar. This study takes a look at emergency responses to natural disasters around the world and their financial impacts on the affected economies. I focus on previous studies which bring to the forefront the need for a restructuring of the insurance industry to better mitigate for and minimize catastrophic losses from major natural disasters. These studies are reviewed and compiled in order to uncover the most cost-effective and efficient ways to reduce catastrophic losses.

This study intends to explore the facts of five recent catastrophic events which include the disastrous Hurricane Katrina in 2005 that devastated New Orleans, the 2008 Cyclone Nargis in Myanmar, the 2008 Sichuan Earthquake in China, the Indonesian tsunami in 2004, and the 2008 Iowa/Midwest floods. These five disasters will be examined to reveal differences in preparation and responses by all parties involved. The purpose of this study is to demonstrate the need for government policies and strategies, as well as revamped mitigation measures around the world, to better cope with natural disasters. A comparison of the governmental failures in the disasters of Hurricane Katrina in the United States and Cyclone Nargis in Myanmar with the successes in governmental responses to the recent Iowa floods and the Sichuan Earthquake in China will be presented to provide case studies for review.

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CHAPTER 1

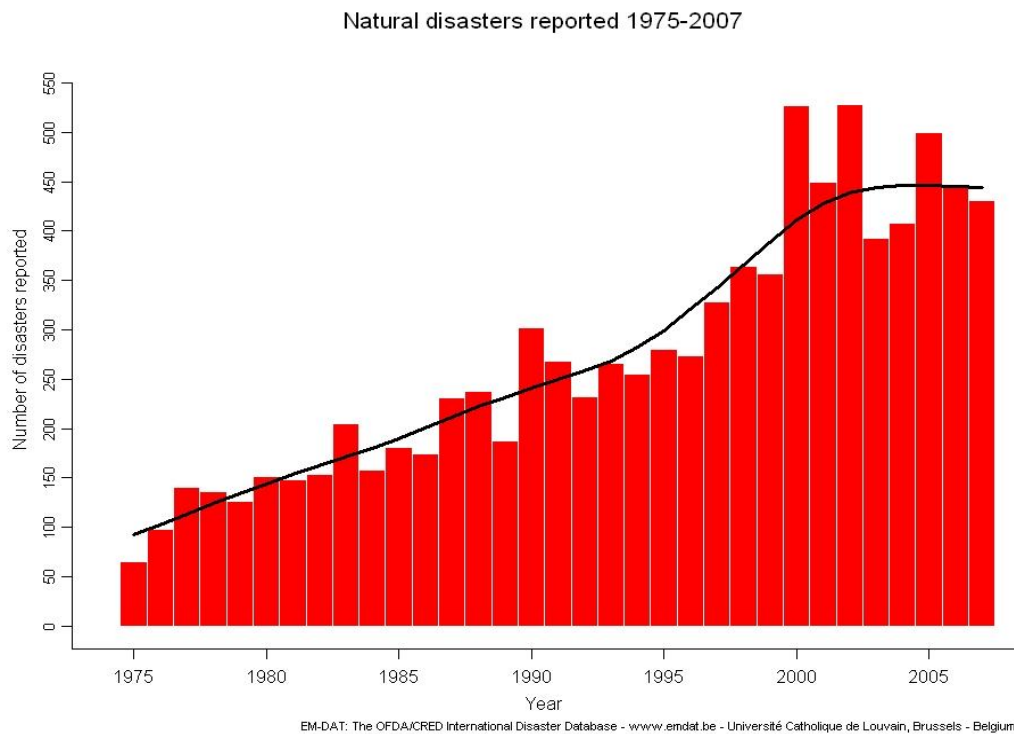
CATASTROPHIC EVENTS AND MITIGATION MEASURES AROUND THE WORLD

Introduction

Over the past fifteen years, there has been a major increase in the cost of natural disasters around the world. The cost of worldwide catastrophes has risen from “\$53.6 billion from 1950-59, \$93.3 billion in 1960-69, \$161.7 billion in 1970-79, \$262.9 billion in 1980-89, \$778.3 billion in 1990-99 to a cost of \$420.6 billion in the current decade” (Kunreuther et al. 2008)¹. The number of natural disasters worldwide has risen five-fold between 1975 and 2005 as calculated by The United Nations. This rise in natural disasters has led to increases in “economic losses per year from \$10 billion in 1975 to \$152 billion in 2005” (Natural Disasters: Reducing Risk, Recovering Faster 2008). Figure 1 below shows the dramatic increase in natural disasters reported from 1975-2007 around the world.

¹ These figures have been adjusted for inflation.

Figure 1: Natural Disasters Reported 1975-2007



Source: EM-DAT database

This study intends to compile and review an extensive amount of literature regarding catastrophic risks and mitigation measures around the world in order to answer the following questions:

- How do the financial impacts of catastrophic risks in emerging and transition countries differ from more developed and stable countries?
- What are the various mitigating measures that can be implemented worldwide and how can they reduce catastrophic losses?
- How can government preparation and response help to minimize the extreme financial impacts that natural disasters have on countries around the world?

- How does government preparation and response to natural disasters differ throughout the United States and International community?

A closer look at five recent disasters will help us to better understand the importance of quality leadership before, during and after catastrophic events in order to hedge losses that will inevitably result from natural disasters. Leadership that provides improved preparation and responses will lead to a minimization of the risk and consequences that are associated with natural disasters. Without an enhancement in the preparation, response and recovery area, costs in terms of lives and finances will continue to increase at an alarming rate.

Throughout the world, natural disasters cause billions of dollars in damages each year. No matter where these catastrophic events such as hurricanes, tsunamis, earthquakes, and floods take place, many countries around the world will feel some effect as a result of extreme costs associated with these events. The three main categories of natural disasters, which are floods, earthquakes and tropical cyclones, account for 90 percent of the world's direct losses and tend to revisit the same geographic zones (Freeman 2000).

An article titled "The Year of Living Diplomatically" was published in the Wall Street Journal and highlights the inevitable costs countries, such as here in the United States, will incur due to the pure generosity of America, its allies and friends which has created expectations. After the tsunami in 2004 in Indonesia, a man cried to a CNN reporter: "Where is America?" This alone demonstrates the impact that the United States has on the rest of the world. Along with these expectations and the generosity of the American people, come costs that the U.S. will inevitably incur from the lack of mitigation measures around the world. The U.S. brought together a group of nations—India, Japan and Australia—to coordinate the relief effort following

the tsunami. This article demonstrates the need for establishing programs and policies to help implement mitigation measures on an international level.

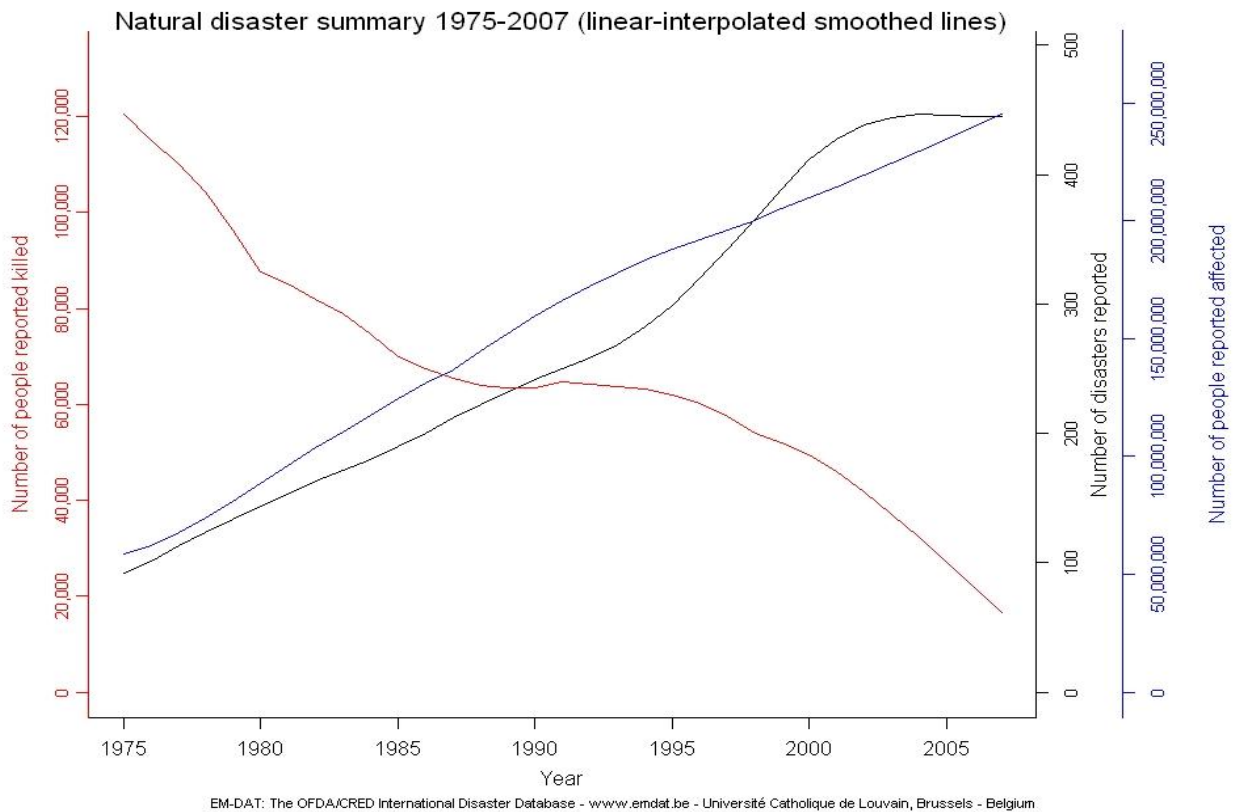
With risks no longer being solely a local problem, the world must work together and form a coalition of sorts in order to protect against worldwide catastrophic events that result in extreme losses. An article published by the Wharton Risk Management and Decision Center (March 2007) called “When Local Risks Become Global Risks, and How We Can Minimize Them” supports the theory that risks are no longer just local, but now global. The article focuses on two measures that will allow for governments to proactively prepare for global risks. The first is having a Country Risk Officer that takes care of managing risks, sets priorities of risks, and upstarts the government’s ability to take preventative actions before disaster occurs. The second is to form a coalition between governments and corporations to more easily minimize the threat against international risks. The world must work together in order to minimize global risks because of the current state of interdependence throughout the modern society (When Local Risks Become Global Risks, and How We Can Minimize Them 2007).

Hurricanes, tsunamis, earthquakes, and floods are among the most costly natural disasters to nations around the world each year. A guideline of criteria is established by the American Red Cross Consultant, Latéfa Belarouci, in order to categorize the occurrence of specific natural disasters as catastrophes. The guideline states that a catastrophe is a disastrous event which results in a large number of victims, considerable material damage, and social disorganization. This study intends to focus on those afore mentioned weather related natural disasters, which can be considered a catastrophe (Belarouci 2004).

Financial Impacts of Catastrophic Events

There have been many studies which provide us with evidence of a dramatic rise in occurrence of catastrophic events around the world. This worldwide increase in catastrophic events has inevitably led to an even more striking ascension in losses. The alarming rise in extreme impacts of natural disasters has led to a substantial amount of studies being performed in order to uncover ways to determine the severity of impacts along with reasons for the dramatic increases. The United Nations has reported that approximately 1.6 billion people have been impacted by way of lost homes, livelihoods or suffered other damage from natural disasters since 2000 (Noy 2008). Schwartz (2006) points out that the number of people impacted since 2000 is a four-fold average annual increase from the 1970s. Figure 2 below shows the decrease in deaths due to disasters, but the increase in number of disasters and number of people affected from 1975-2007.

Figure 2: Natural Disasters Summary 1975-2007



Source: EM-DAT

Much of the research has been conducted on preparing for and increasing the ability of predictions as well as mitigating costs. This becomes evident as the number of lives due to natural disasters has declined throughout the decades with 800,000 people losing their lives as a result of such disasters in the 1990's, down from 2 million deaths in the 1970's. Even though the number of deaths has decreased, the number of people affected by natural disasters has tripled over the past decade to 2 billion (IRIN 2005). Reasons for the dramatic increase could include a lack of insurance and other mitigation measures, deficient disaster risk management plans, or

ineffective government policies. Regardless of the reasons for the increase, few studies focus extensively on the *ex post*² impact that natural disasters have on the macro-economy (Noy 2008).

Studies such as Jovel (1989), Anderson (1991), and Gilbert and Kreimer (1999) have observed the adverse affects that natural hazards cause on long-term development.

Contradictory studies, such as Albala-Bertrand (1993), suggest that economies improve with an increase in the GDP growth rate following a disaster. This theory stems from the idea that the random event of a disaster forces the “adoption of improved innovations” and therefore, leads to positive economic growth. Benson and Clay (2004) offer studies that have observed both short and long-term effects of a country’s GDP as a result of a natural disaster. Several studies have concluded that short-term declines in the GDP are common following a disaster, but as in Charvériat’s study (2000), there tends to be wide variations in the level of inter-annual fluctuations in GDP. These variations are the work of multiple variables, and therefore do not fully reflect the amount of direct losses.

Negative long-term impacts on the economy of a country following a disaster are the result of capital assets and other resources being severely damaged. Disruption to infrastructure and markets often reduces the productivity of undamaged capital and labor causing long-term damage to an economy. There are several ways that natural disasters can “disrupt longer-term investment plans for both physical and human capital.” In order to provide assistance with the relief and rehabilitation process, governments create a diversion of funds and resources away from already planned investments. While some assets that are destroyed by a disaster may never be replaced, public reconstruction is costly and funded with either domestic or external borrowing that leads to an increase in future debt-service payments. Investors are often deterred

² Ex post signifies mitigation measures implemented after the event.
Ex ante signifies mitigation measures implemented before the event.

from investing in countries for the long-term when it appears that there may be an “atmosphere of uncertainty” surrounding a particular region or country. As investors steer away from investing in a specific area, they automatically contribute to the increase in economic instability of the country (Benson and Clay 2004).

Noy (2008) discusses and examines the *ex post* impacts of natural disasters on the macro-economy. The author uses a comprehensive international macroeconomic panel dataset in order to determine the costs of forgone production. This allows the costs of crises to be measured and estimated as well as provides researchers and other interested parties with the capabilities to “compare the costs of disasters across geographical areas and income levels and provide answers to several hypotheses regarding structural and policy-related aspects of these costs.” For this particular study, Noy uses data from the EM-DAT database which is compiled by the Centre for Research on the Epidemiology of Disasters (CRED) from various sources such as UN agencies, non-governmental organizations, insurance companies, research institutions, and press agencies. The author attempts to estimate secondary effects as opposed to direct damages by observing the magnitude of the disaster. Data consisting of the number of people killed, affected, and the amount of direct damage caused by disasters from 1970-2003 are used in this study. A standardized disaster measure is formed on the presumption that “the impact of a specific natural disaster on the macro-economy depends on the magnitude of the disaster relative to the size of the economy.”

There is no evidence found in Noy (2008) of a correlation between the number killed or affected and the GDP growth, but does observe a “strong indication that the amount of property damage incurred during the disaster is a negative determinant of GDP growth performance.” Noy concludes that when measured by the amount of property damage incurred, there is an

impact on the macro-economy. Although the amount of property damage has an impact on the macro-economy of a country, the number of people killed and affected is not found to “present any statistically identifiable evidence of macroeconomic costs (Noy 2008).”

Noy acknowledges that there are other impacts on the macro-economy which are not examined in this study and may have implications on policy-making following disasters. The author also recognizes that *ex post* policy changes are not examined in this study and can be brought about by disasters resulting in various impacts on the situation (Noy 2008).

Where Noy (2008) examines the short-run impacts on the macro-economy of rapid onset disasters, Skidmore and Taya (2002) observe the long-run impacts of disasters on growth. The study looks at the frequency of natural disasters from 1960-1990 for each country in order to determine long-run trends. A measure of the frequency of natural disasters normalized by land size is used to uncover its correlation with the average measures of economic growth, physical and human capital accumulation and total factor productivity for the 1960-1990 period of time. The authors find a “positive partial correlation between the frequency of climatic disasters and total factor productivity growth for a cross-section of 89 developed and developing countries (Cuaresma, Hlouskova and Obersteiner 2004).” Skidmore and Taya conclude that this positive partial correlation is a result of the opportunities that disasters provide countries to update capital stock as well as invest in and adapt new technologies.

Kunreuther and Michel-Kerjan (2007) concentrate on the evolution of weather-related catastrophic events over the past 20 years. The authors point out a spike in the development of hazard-prone areas that has led to a substantial increase in catastrophic losses. Insurability of earthquakes, hurricanes, and floods are observed as the authors find that simply the private sector is unable to insure certain areas from weather-related events because of the recent large

catastrophic losses that have occurred. Kunreuther and Michel-Kerjan suggest giving incentives such as premium reductions and rate credits to those that invest in the risk-reducing measures.

Kunreuther, Orth and Roth (1998) observe a dramatic increase in insured losses from catastrophic events. The authors discuss insurance success in situations of low-probability, high-consequence events and the use of different policy tools to help increase effectiveness.

Challenges of the private and public sectors are discussed in addition to the case studies of Hurricane Andrew in 1992 and the Northridge earthquake in 1994. The book gives suggestions to help provide funds for those affected as well as to reduce the amount of future losses.

Impacts on Emerging/Developing Economies

Studies have shown that the impacts of catastrophic events in countries with emerging economies are much more detrimental to those particular economies than that of developed countries. Catastrophic events create high costs in hazard-prone countries that result in unwanted financial pressure on the government's mitigation and preparedness projects. Benson and Clay (2004) find that these hazard-prone countries are often made up of poorer nations that are unable to deal with the extra burden on the government. According to the World Bank in 2000, natural disaster losses in developing countries are 20% greater than in industrial countries as a proportion of GDP (Varangis, Skees and Barnett 2002). The large portion of GDP being affected is a result of dependence among many developing economies on agricultural success, which is directly affected by catastrophic weather events (Varangis, Skees and Barnett 2002).

A study by the United Nations Development Programme proved that poor countries and their people really do pay the highest price as a result of catastrophic events. The study revealed that while "only 11 percent of the people exposed to natural hazards live in poor countries, these

people account for more than 53 percent of deaths recorded from natural disasters. Therefore, suggesting that the developing nations which implement the proper prevention, preparation, response, and recovery measures are presented with the great and real potential for reducing future losses (Fritschel 2005).

Developing countries suffer much larger economic losses in comparison with their GDP than developed countries due to limitations in their capacity to reduce risk (DFID 2005). Such countries have experienced an average of \$35 billion USD in direct losses from natural disasters over the past 10 years. These direct losses are comprised of damage to and loss of capital assets to make up a financial value. Indirect losses are measured by the loss of output and earnings as a result of the interruption of production and services. The increasing amount of losses in developing nations comes as a result of social factors, an increasing concentration in hazard-prone urban regions along with larger, and more frequent weather-related events (Freeman 2000).

A 2005 briefing by the Department for International Development (DFID) provides a definition of disaster as “a severe disruption to a community’s survival and livelihood systems, resulting from people’s vulnerability to hazard impacts and involving loss of life and/or property on a scale which overwhelms their capacity to cope unaided.” This definition of disaster provides insight on the essence of the severity of impacts that such events have on developing countries. Developing countries contain all of the characteristics which increase their vulnerability to such catastrophes (DFID 2004).

Even small-scale disasters present developing countries with a multitude of macroeconomic impacts in various ways, such as physical damage directly to the country’s infrastructure, and damage to productive capital and stocks. Impacts are also felt indirectly,

presenting long-term problems such as affects on growth, productivity and macroeconomic performance. All of these problems arise in the poorer countries because of often increases in food prices along with loss of tax revenue and resources being taken from other areas in order to provide for disaster response following a catastrophic event. The briefing points out that many of the funds that are diverted by governments and donors to provide disaster relief and rehabilitation are taken away from development programs. A domino effect can then be witnessed as the country takes strides the wrong way as it becomes unable to continue sustainable growth and reduce poverty among the people (DIFD 2004).

Noy (2008) finds that much larger shocks occur to the macro-economies of developing countries than events of “similar relative magnitude” in developed countries. The author reconfirms previous findings that developing countries bear the brunt of larger initial costs than those of developed countries. There are also found to be larger indirect impacts on economic activity in these developing countries for reasons that have not yet been precisely determined. Noy investigates the determinants of output costs by observing literacy rates, quality of institutions, per capita incomes, size of government, and degree of openness to trade in order to establish potential reasons for developing countries incurring more damage to the macro-economy due to natural disasters than developed countries. It is discovered that a country with higher literacy rates, better institutions, higher per capita incomes, larger governments, and higher degree of openness to trade seem to be able to hold up through the initial disaster shock as well as keep its effects from further causing damage to the country’s macro-economy.

Noy (2008) also points out a connection between the financial condition of a country and its ability to prosper despite the costs of a natural disaster. Countries that are able to remain stable and endure shocks without bearing witness to harmful effects on GDP growth rates

following natural disasters were found to have less-open capital accounts, more foreign exchange reserves, and higher levels of domestic credit.

A country's infrastructure, government policies, and economic stability are particularly important in the event of a catastrophe. Since a natural disaster is the result of human vulnerability, the higher vulnerability of poorer countries also plays a major role in the impacts that catastrophic events have on developing or emerging economies. These impacts on developing countries disrupt their long-term efforts to attain sustainable growth (Freeman et al. 2003). In 1998, Hurricane Mitch pummeled Honduras, destroying the country's infrastructure, wiping out crops, leaving thousands of families without a source of income and tens of thousands more homeless. This storm was said to have set-back the development of Honduras by 50 years (Fritschel 2005). This comes from the reality that smaller developing nations must contend with natural disasters resulting in losses that represent a major percentage of their GNP. With such great losses, developing countries bear witness to very long-term negative impacts on their economies (Krimgold and Vatsa 2000).

Freeman et al. (2003) note that when developing nations are confronted with a natural catastrophe, a sharp increase in poverty is soon to follow. The author finds that these poorer countries "can improve their ability to absorb the cost of natural disaster events if they incorporate an analysis of the chronic economic impact of catastrophes into their planning process (Freeman et al. 2003)." This analysis of the economic impact is a result of the magnitude of direct losses from the event as well as the economic resilience of the country at the time of impact, not after the disaster has happened. The expected severity and the expected frequency of catastrophic events must be measured in order to estimate the economic impact of chronic exposure to natural disasters. A methodology must be produced that incorporates this

loss exposure and the expected macroeconomic situation of a country when the catastrophes strike. This will provide a tool that is necessary “to understand the potential chronic impact of catastrophes on the long-term development of a country and to incorporate catastrophes in the planning process (Freeman et. al 2003).”

Freeman et. al (2003) find that indirect and secondary impacts of catastrophes are amplified by the high hazard risk and high vulnerability to macroeconomic losses. These secondary impacts include “disruption of development plans, increased balance of payment deficits, increased public sector deficits and debt, and worsened poverty.” The author also discovers that highly indebted countries that have a high catastrophe exposure should not rely on external debt to finance post-disaster reconstruction as a long-term policy option. Therefore, in order to plan for long-term development, a vulnerable country must recognize its natural disaster exposure as well as the impacts that a catastrophic event may have on the country.

Dilley et al. (2005) discuss both the humanitarian and economic issues associated with catastrophic events. The authors point out that there are many costs related to a natural disaster such as relief, rehabilitation, and reconstruction. These costs come along side of the human and economic losses that a country must also endure as a consequence of natural disasters. The authors find that losses can be reduced through the reduction of either the exposure or vulnerability present to countries in hazard-prone areas making them key components for sustainable development.

Kunreuther and Linnerooth-Bayer (2003) find that governmental response in emerging and transitioning countries have a large financial impact on investors around the world. This is due to the inability of residents of these countries to take preventative measures, such as, insurance in order to hedge against catastrophic risk. Kunreuther and Linnerooth-Bayer look at

the case of the 1997 catastrophic flood in Poland. It becomes difficult for governments in emerging or transitioning economies to prepare for natural disasters due to the large number of low income residents as well as the lack of private insurance. Post-disaster measures to raise funds are just as hard for governments to employ “because of fiscal, political, and other constraints on borrowing, taxes, or diverting funds from other domestic budgets or internationally financed projects (Kunreuther and Linnerooth-Bayer 2003).” The article looks at the pros and cons of hedging instruments against financing instruments. In examining the 1997 catastrophic flood in Poland that caused approximately \$3 billion worth of damage or 2.7% of the country’s GDP, Kunreuther and Linnerooth-Bayer discover that hedging instruments may be of great importance in the recovery of poor countries from natural disasters that cause catastrophic damage. These hedging instruments or *ex ante* risk transfer mechanisms can come in the form of insurance for the government where the government is financially protected by paying a premium, or capital-market based securities where the interest is paid as protection against catastrophic events.

Kunreuther, Meyer, and Michel-Kerjan (2007) discuss the increasing costs of natural disasters over recent years with all 20 of the most costly catastrophes occurring since 1987 (9/11 terrorist attacks are included in the top 20 and rank number 2). It is observed that most emerging economies do not have the current capabilities such as warning systems and effective mitigation programs that help reduce the consequences of natural disasters. The authors find that the public and private sectors must work together in order to reduce future losses from natural disasters and simultaneously limit government assistance. Well-enforced building codes, land-use regulations tied with insurance protection, and economic incentives in the form of long-term loans and subsidies are all proposed as solutions to preventing large-scale disaster relief.

IFPRI Forum (March 2005) “When Disaster Strikes” as reported by Heidi Fritschel discusses vulnerability of poor citizens and countries in the event of natural disasters such as the December 2004 earthquake and tsunami in the Indian Ocean. There are mitigation measures that could have been implemented in order to prevent the loss of life and property from the tsunami. Many of these mitigation measures have been implemented in places such as Japan, which would have been well prepared for the incredible wall of water. Japan has installed a Tsunami Warning System that gives 10 minutes advanced notice of an incoming wave as well as “an extensive array of tsunami walls, shelters, and floodgates” in order to help protect the country’s coastline. Instead of a minor effect on Japan, the tsunami directly hit several countries throughout the Indian Ocean such as Indonesia and hampered their economies by destruction of infrastructure, fishing fleets, and industry means (Fritschel 2005). The conference highlighted the making of a natural disaster which occurs “when a natural hazard (such as an earthquake, cyclone, or drought) intersects with human vulnerability (such as poor building standards, inappropriate land use, or lack of knowledge about and preparation for the hazard);” therefore, explaining that the high vulnerability of poorer countries is why they are far more susceptible to extreme losses from disasters (Fritschel 2005).

Developing countries have the ability to effectively prepare for disaster, but as Margaret Arnold of the World Bank’s Hazard Management Unit states, “poor countries tend to think of investments in disaster prevention and preparedness as luxuries that they can’t afford (Fritschel 2005).” This is not necessarily the case as studies have demonstrated that focusing on disaster preparedness instead of solely recovery can be more cost-effective. Developing countries such as Bangladesh, which is considered the most disaster-prone country in the world due to its subjectivity to cyclones, flooding, storm surges, droughts, tornadoes, and earthquakes, have

proven that poor countries can be effective in preparing for disasters. The country has focused its attention on disaster preparedness following a 1970 cyclone that killed approximately 500,000 people and built cyclone shelters along the coastline as well as implemented rapid evacuation procedures. These mitigation measures have saved millions of lives according to the World Disasters Report 2002 (Fritschel 2005).

In 1998, a flood covered the majority of Bangladesh and destroyed more than 2 million tons of rice crops. The country was obviously affected, but it was prepared as the government had developed a new strategy in order to avoid a food crisis. The new strategy called for the private sector to step up with imports of rice from India which kept stable prices in the marketplace. The government then “directed well-targeted food transfer programs to the neediest people (IFPRI 2005).” Undoubtedly, the disaster preparedness of the country’s public and private sectors prevented the country from experiencing a major economic set-back that would have resulted in a rise in poverty levels (Fritschel 2005).

Skidmore and Toya (2005) conclude that private entities, governmental, and not-for-profit organizations work to implement mitigation measures in developed countries according to the risks at hand. The authors find that low-income persons and nations see precautionary measures as too expensive and therefore, not feasible. The available knowledge and technologies are not deemed necessary for those in poverty as the costs to implement the measures outweigh the expected benefits.

Skidmore and Toya (2005) discover that the overall safety of a country is increased as strides are made towards the economic development. Once this step has been taken, the country will begin to transition into a more developed state. The result of becoming a more developed state is then a reduction in death tolls and damages/GDP as a result of natural disasters.

The main conclusion of Skidmore and Toya (2005) is that income is not the only important measurement of development in reducing deaths and damages/GDP. The authors reveal that “higher educational attainment, greater openness, a well-developed financial sector and smaller government are also important (Skidmore and Toya 2005).” This being said, policymakers have somewhat of an opportunity to control development factors in order to reduce losses. Controllable factors include more direct disaster mitigation efforts, improvement of education, an increase in openness, and expansion of the development of financial markets (Skidmore and Toya 2005).

Llanto (2007) focuses on providing risk protection from catastrophic events for poor households by looking at a case in the Philippines. The study investigates the emerging market of microinsurance in the Philippines, and its apparent ability to protect low-income households against catastrophes; providing security while minimizing transaction costs and any problems of asymmetric information.

Kron and Thumerer (2002) discuss catastrophic floods throughout European countries as well as the insurance industry and the role of reinsurance. The authors look at the issue of land-use and the effects this issue has on flood losses. They also observe and present reasons why impacts on poorer countries are greater than that of other countries. Kron and Thumerer observe an increase in both the frequency and intensity of floods in recent years with more than \$250 billion being provided by countries all over the world in order to compensate for flood losses. Flood-prone land next to rivers has been reclaimed through the use of engineering structures such as dikes and declared as residential areas by local governments. This gives individuals a false sense of security as potential buyers do not anticipate flood hazards being located in areas zoned for residential properties.

Poor countries are prone to natural disasters, in particular earthquakes, that kill thousands of people. This is due to a higher number of people and the poor quality of structures as well as very little warning with earthquakes. The ability to somewhat detect floods early has effectively helped to reduce the amount of lives lost due to catastrophic floods. The authors define natural catastrophes as “being great if they cannot be handled by the affected country/region alone, but require interregional and international assistance (Kron and Thumerer 2002).”

Kron (1999b) finds that dramatic increases in the world’s population in certain areas have resulted in many people settling in many dangerous areas.

Varangis, Skees and Barnett (2002) discuss measures taken by the international community to reduce the economic impact of weather disasters. The authors find that weather risk markets can offset the financial impacts and potentially play a role in alleviating human suffering in developing countries. Weather risk markets can be used by policy-makers “to develop and reinsure effective disaster assistance programmes that are activated by specific catastrophic weather events that have been defined ex ante (Varangis, Skees and Barnett 2002).” Barnett, Skees, and Varngis also find that aid should not be used to stimulate new economic activity in areas that are highly vulnerable to natural disasters as the next disaster will cause more losses and suffering. The article suggests that a balance should be established between government disaster assistance and private risk management in order to keep from crowding-out each other. The authors conclude that the balance should begin with “segmenting and layering risks” in order to allow for government aid to cover the most catastrophic risk while private market mechanisms are left to handle the lesser of the catastrophic risk (Varangis, Skees and Barnett 2002).

Private insurance, along with reinsurance markets in developing countries, can be supported by international weather markets through the transfer of systemic weather risk to financial intermediaries around the world. Without the use of international weather markets, private insurance and reinsurance companies in developing countries are unable to diversify the risk outside of their country and therefore cannot cover the losses from natural disasters (Varangis, Skees and Barnett 2002).

Goes and Skees (2003) examine the sources of relief funding for natural disasters that occur in low and middle income nations and uncover different problems associated with traditional sources of disaster relief funding. They discover that low and middle income countries are “limited in their capacity to absorb widespread damage brought about by catastrophic events” due to limited budgets, and therefore “negatively impact the poorest, marginalized sectors within an affected community.” The study proposes the use of charity catastrophic bonds rather than traditional CAT bonds as it enables low-income countries to more effectively use them by reducing the premium for catastrophic coverage. Although the premium is reduced, *ex ante* measures are still required in coordination with government agencies and aid organizations.

Kunreuther (2001) discusses the importance of private-public partnerships for disaster management. The author focuses on strategies that will reduce losses from natural disasters in developing and emerging economies as well as provide financial resources for the affected areas. Kunreuther finds that a strategy of combining building codes, reinsurance and indexed CAT bonds can be formulated in order to effectively reduce losses for property owners, insurers, and the investment community.

Margaret Arnold of the World Bank suggests lessons that governments of developing countries can learn from disasters such as Hurricane Mitch in 1998. The director/program manager of the World Bank's Hazard Management Unit proposes that countries pay more attention to livelihood recovery following a catastrophic event. Many times, families are left without a source of income immediately after a natural disaster and therefore, fall even further into poverty. Livelihoods can be rebuilt through the use of local labor to help with the removal of debris as well as with the reconstruction efforts, giving cash payments in support of livelihoods, and promoting microfinance programs (Fritschel 2005).

Krimgold and Vatsa (2000) find a strong correlation between the growing incidence of disasters with the increasing vulnerability of households and communities in developing countries. The impact of a disaster is greatly intensified because of socioeconomic vulnerabilities. Not only do these vulnerabilities worsen the impact, but also complicate the process of recovery and rehabilitation. The authors point out that the impact on the population and economy of natural disasters in developing countries is much greater due to the reality that there is a higher level of economic and social vulnerabilities than is seen in developed countries. This can be seen, for example, by observing the consequences of the 1997 central European floods along the River Oder. The Czech Republic, Poland, and Germany were all affected by the River Oder overflowing its banks, but the floods did not have the same impact on Germany as it did the Czech Republic and Poland. These floods resulted in much greater losses to the Czechs and Poles even though the Germans are their neighbors on the opposite side of the river. This came as a result of a higher level of vulnerability within the poorer countries. Poland was a much poorer country than Germany and therefore had neglected flood defenses. To go along with the weakened and outdated dykes, there were very few people insured in Poland and the

government lacked the resources to provide assistance through either rebuilding or compensation.

Krimgold and Vatsa (2000) also elude to the fact that high population growth in these developing countries combine with poverty, as well as continuing urbanization lead officials to make poor decisions about the use of land. People are housed in disaster-prone areas, but at the same time there is a lack of emergency services and infrastructure within these areas to cope with catastrophes.

A comparison of costs associated with the recovery of disasters in developed and developing countries by Anderson (1990) finds the following four reasons for the higher costs in developing countries:

1. Losses due to disasters as a percentage of national wealth are higher in developing than in developed countries.
2. Disasters and poverty are mutually reinforcing.
3. Frequent incidences of disasters have a negative impact on investment and entrepreneurial incentives that are necessary for development.
4. Disasters have special negative impacts on the non-formal economic sector, and in countries in which this is an important sector, estimates of the costs of disasters are consistently underestimated.

Aysan (1993) studies the critical elements which contribute to the high vulnerability of people to natural disasters. The criteria have a high correlation to the individuals living in developing countries as the criteria tend to be characteristics of poor households. The following criteria impede on peoples' ability "to protect their livelihood and their relationship with state or other social and political structures on which the people make claims for protection":

- Lack of resources (material/economic vulnerability)
- Disintegration of social patterns (social vulnerability)
- Degradation of environment and inability to protect it (ecological vulnerability)
- Lack of strong national and local institutional structures (organizational vulnerability)
- Lack of access to information and knowledge (educational vulnerability)
- Lack of public awareness (attitudinal and motivational vulnerability)
- Limited access to political power and representation (political vulnerability)
- Certain beliefs and customs (cultural vulnerability)
- Weak buildings or weak individuals (physical vulnerability)

In establishing these criteria, Aysan concludes that highly vulnerable groups are even more severely impacted by small shocks than groups with low vulnerability are with high shocks (Aysan 1993).

Therefore, the key in developing countries is reducing the risks and vulnerabilities of poor households. These risks and vulnerabilities can be reduced by investment and implementation of a mitigation strategy. Resources must be provided to poor households which can only be accomplished as a collaborative effort in “pooling resources, sharing knowledge on hazard mitigation, and community participation (Krimgold and Vatsa 2000).” The article calls for households, financial institutions, and governments to bring together their resources for risk reduction and mitigation measures. The authors also discuss the need for a sufficiently enlarged risk pool with a great deal of participation in order to prove effective as risk reducing mechanisms for natural disasters. Participation of the poor in all activities that reduce their vulnerability is required in a sustainable mitigation strategy (Krimgold and Vatsa 2000).

Dayton-Johnson (2006) focuses on reducing vulnerability to those countries in the developing world by observing multiple country experiences with natural disasters. The author finds that there are differences in the ‘adaptive capacity’ of different countries and therefore witness results that differ following a disaster. Adaptive capacity is defined as “a combination of a society’s *ex ante* (i.e. before the fact) vulnerability to damages from natural hazards and its *ex post* (i.e. after the fact) resilience or ability to cope with the damages that result (Dayton-Johnson 2006).” The difference between a natural hazard and a natural disaster is the result of which depends on the ability of communities and governments to handle the hazard at hand. Therefore, “disasters occur when societies are vulnerable to such hazards (Dayton-Johnson 2006).”

Dayton-Johnson finds an increase in the threat of natural disasters, including earthquakes, floods, and windstorms, to developing economies. The ‘shocks’ associated with these disasters produce long-lasting damage to buildings, homes, and infrastructure to go along with numerous injuries and fatalities (Dayton-Johnson 2006).

The study finds that higher vulnerability and lower resilience of a country is directly associated with “unfavorable economic and social conditions such as irregular urban settlements and weak regulatory practices (Dayton-Johnson 2006).” The author concludes that vulnerability can be reduced with help from governments. Governments can develop programs to increase the skills, health, and physical assets of the poor as well as implement and strictly enforce building codes and standards. Other programs such as social safety nets and improved communications can be implemented as precautionary measures to help lower relief costs along with adequate medical and humanitarian response plans (Dayton-Johnson 2006).

Although governments are important in the reduction of a country’s vulnerability, they do not play the only role in reducing this vulnerability. The private sector alongside international

agencies plays a role in returning a country to a sustainable growth path following a natural disaster. New financial instruments must be created in order to pool disaster risk as well as provide insurance against that risk such as the rainfall-based crop-insurance programs that use international public funding (Dayton-Johnson 2006).

Reducing Catastrophic Losses through Mitigation Measures

Preparation is what many believe to be the single most important element in reducing losses from catastrophic events. Although a proper response can reduce losses in terms of lives and property, the majority of the reduction takes place before the disaster ever occurs. One might question the cost-effectiveness of investing in mitigation measures and even present the question if mitigation measures are so cost-effective, then why doesn't everyone invest in them? Many studies have taken place that aimed to determine the answer to this question.

The majority of studies find that people do not believe disasters will happen to them. Even after the occurrence of multiple disasters people tend to forget the impacts of the storm and therefore will not take the appropriate mitigation measures. A study completed by the World Bank and U.S. Geological Survey observed disaster preparedness, mitigation, and prevention during the 1990's. The study found that if \$40 million would have been invested into disaster preparedness, mitigation, and prevention measures, a sevenfold return would have been realized by reducing losses by \$280 million (Fritschel 2005).

Another study conducted by the partnership of Discipleship Centre and Tearfund worked with the villagers of the Indian state of Bihar, which witnesses annual flooding, in order to implement mitigation measures. The villagers took the initiative to prepare and prevent losses by building "embankments that serve as evacuation routes, installed hand pumps whose spigots

are raised above likely flood levels so that drinking water is not contaminated, and developed evacuation procedures (IFPRI 2005).” The analysis later revealed that the flood preparedness resulted in a cost-effective investment as it returned 3.8 rupees in benefits for every 1 rupee invested (IFPRI 2005).

Andersen (2002) observes the insurance, reinsurance and new capital market instruments that continuously absorb impacts from natural disasters. The author explains how the losses from catastrophes are insured and discusses those ultimately responsible for the costs of compensating the insured assets. Although there has been rising concern over the increase in natural disasters in recent years, “less than one fourth of all losses emanating from natural disasters around the world are insured (Andersen 2002).” This comes as a result of only private assets in developed countries being covered against natural disasters. Meanwhile, developing countries do not see committed financial coverage even in the private sector. The author finds a need for encouragement of prevention and mitigation efforts in order to reduce vulnerability to natural disasters. These prevention and mitigation efforts consist of many measures, but specifically urban planning, enforced building codes, titling of properties, and emergency contingency plans (Andersen 2002).

Andersen (2002) also finds a need for improved preparedness that will help protect the poorest populations with more effective responsiveness. The economic infrastructure can be quickly and effectively repaired through “reasonable risk financing arrangements (Andersen 2002).” There are new risk transfer and contingent funding instruments, such as layered reinsurance contracts, risk-linked securities, catastrophe risk swaps, and contingent surplus notes, which have been developed to modify the risk management profile of countries. The integration of all such elements into a country’s risk management strategy will provide complementary

solutions. This along with the ability of international financial markets to absorb catastrophic risk exposures offer an opportunity for countries to reduce losses associated with such disastrous events (Andersen 2002).

People have many reasons for lack of mitigation investment and preparedness, whether it has to do with one's financial situation or the feeling of invisibility from a catastrophe that one might have. Numerous studies have looked at the mental state of homeowners and their reasons for choosing to accept the risk and ultimately pay the price following a natural disaster.

Graham, Hall, and Schuhmann (2007) focus on the recovery of those real estate markets exposed to catastrophic events, in particular hurricanes in the Cape Fear Region of North Carolina. This area was hit by four significant hurricanes in the years 1996-1999 with not much change in the real estate market coming from the first two hurricanes in 1996. This study confirms findings from an earlier study by Graham and Hall (2001, 2002) that the first couple of hurricanes are just considered 'bad luck', but the repercussions from the last two storms in the series "were successively more extreme and more immediate." In using a Chow test, it is observed that prices seem to recover and stabilize approximately one year after the last hurricane struck the Southeastern North Carolina Coast; therefore, concluding an early overreaction to perceived catastrophic risk in the area is calmed down as time goes on and the string of events is more-or-less forgotten.

As previously mentioned Graham and Hall (2001, 2002) find that home sales in the Cape Fear Region of Southeastern North Carolina were negatively affected following the landfalls of the last two hurricanes out of a series of four hurricanes. This was due to the appearance that the area had incurred a greater probability of hurricane risk resulting in a change in housing prices.

Graham, Hall, and Schuhmann (2008) find that implied perceptions of increasing catastrophic risk results in a negative impact of home buyer sentiment. This leads to a wider spread and fewer units sold as potential home-buyers expect for property losses to be large in the future.

Kunreuther (1996) develops the idea of the natural disaster syndrome following the idea where individuals living in hazard-prone areas do not take advantage of cost effective loss reduction measures voluntarily.

According to a study by the World Bank and U.S. Geological Survey in a Wall Street Journal titled “Wonder Land: Forget the Planet, Retrofit the Earth,” discusses preparation as the key to mitigating damages instead of response. It looks at Hurricane Charley in 2004 which devastated the Caribbean and U.S. causing more than \$8 billion in insured losses. A study done by the Wharton Business School’s risk management center concluded that residences built to wind-resistance standards developed since 1996 had a 60% lower claim frequency than those built before 1996. Thus the better mitigated homes experienced less costs and destruction. It was then hypothesized that mitigation strategies would reduce the damage of a 100-year hurricane in Florida by 61%.

There are many protective techniques and technologies that have been developed in recent years to help reduce damage from high wind and water surges. There have been studies that analyzed “wind flows across roofs and siding, damage from wind-driven projectiles and water infiltration through windows, roofs, doors, and foundations” which resulted in these new building materials and techniques (“Wonder Land: Forget the Planet, Retrofit the Earth). The more vulnerable homes are not retrofitted due to the distortions in pricing insurance risk. These strategies of readiness have been transferred to other parts of the world. For instance, India

refused U.S. help following the 2004 tsunami as it had already addressed disaster readiness following the 2001 Bhuj earthquake (“Wonder Land: Forget the Planet, Retrofit the Earth”).

Kleindorfer and Kunreuther (1997) look at reducing losses from hurricanes and earthquakes with specific risk mitigation measures. The authors focus on the earthquake-prone city of Oakland, California and the hurricane-prone city of Miami/Dade County, Florida to model the impact of a risk mitigation measure on expected losses as well as worst case scenarios. Kleindorfer and Kunreuther find that public-private partnership programs are necessary in order to encourage the use of mitigation measures. This conclusion arises from an examination of three types of public-private partnership programs: building codes, premium reductions linked with long-term loans for mitigation and insurers offering lower deductibles for those investing in mitigation.

Howard Kureuther wrote an article that appeared on Forbes.com on February 11, 2008 entitled “Flirting with Disaster.” This article proposes the use of long-term insurance that is tied to a mortgage of 15-30 years with the annual premium being included in the monthly mortgage payments. This would allow for insurers to price their coverage in a free market resulting in premiums that reflect risk.

In a September 2006 conversation with Kunreuther and Michel-Kerjan regarding their book titled *Seeds of Disaster, Roots of Response: How Private Action Can Reduce Public Vulnerability*, Kunreuther and Michel-Kerjan offer strategies for firms and individuals to invest in cost-effective protective measures reduce impacts of disasters such as Hurricane Katrina from occurring. The article discusses bringing both the private and public sectors together and provides an example of how this will be able to create incentives for individuals that invest in

mitigation measures. Kunreuther also describes how insurance rates should reflect risk and the way in which the risk should be measured.

Kunreuther (2008) describes the increase in impacts of catastrophic events over the past twenty-five years worldwide due to an influx in natural disasters. There is also a rise in costs associated with these natural disasters as a result of an influx of development in hazard-prone areas. Kunreuther finds that significant reductions in future disaster losses can be obtained through constructing old and new homes with better designed structures. Individuals generally underestimate the risk and seem to only focus on their short-term financial situation in overlooking cost-effective mitigation.

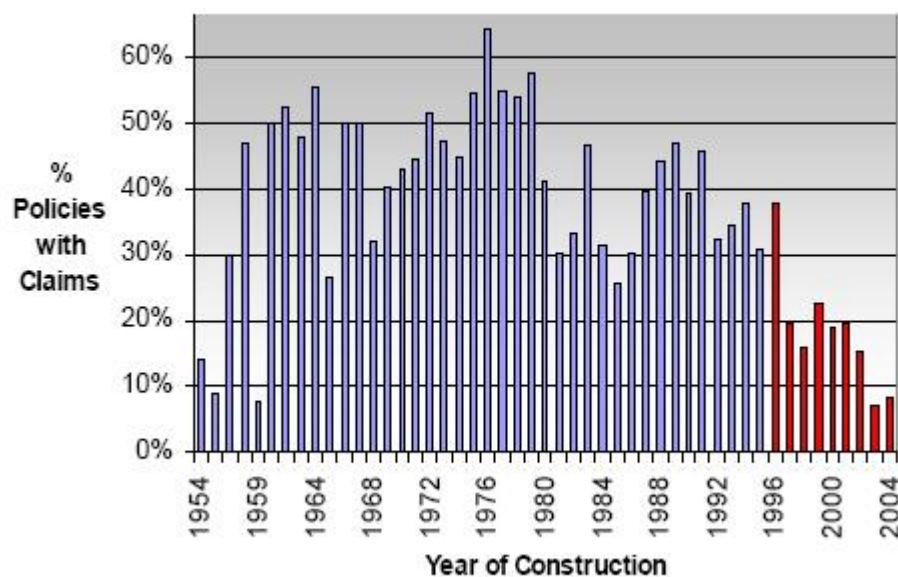
Kunreuther et al. (2008) address the issue of who is responsible for paying the costs associated with catastrophic losses in hazard-prone areas. The study observes an increase in catastrophic events and losses in recent years and investigates ways to implement programs to help with the recovery from large-scale disasters. The authors find ways to better insure against extreme losses in hazard-prone areas while encouraging investment in loss-reduction measures against future natural disasters. The underlying findings in the study call for “changes in state regulatory involvement, premiums reflecting risk, adherence to building codes, and a means to provide affordable insurance coverage to residents of hazard-prone areas who have financial need” in order to minimize future losses (Kunreuther et al. 2008).

A study by the Institute of Business and Home Safety examines the state of Florida’s reaction and implementation of stronger building code standards following the devastation witnessed from Hurricane Andrew in 1992. Building codes were strictly enforced by the state along with a training and education program that included a requirement of all licensed builders to participate in a course on the new building code. New high wind-resistant standards were

enforced at the end of 1995 with the first full year of enforcement being 1996. The study looks in particular at Charlotte County in Florida and gives consideration to the Florida Building Code that was implemented in 2002. The codes were soon after put to the test by several hurricanes in 2004 and 2005, but in particular by Hurricane Charley in 2004 which was the focus of the study (IBHS 2007).

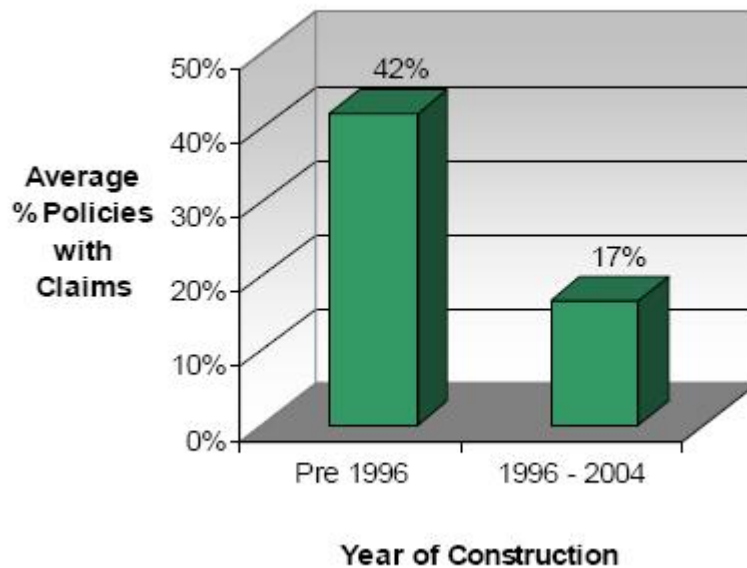
The study focused on the effectiveness that the high wind-resistant standards along with the Florida Building Code of 2002 have had on the reduction of losses was constructed following Hurricane Charley in 2004. The study also revealed that “homes built under the new-wind resistant standards that were enforced in 1996 had a claim frequency that was 60 percent less than those that were built prior to 1996 (Kunreuther et al 2008).” Homes that were built pre-1996 had an average claim amount of \$24 per square foot while homes that were built between 1996 and 2004 averaged \$14 per square foot as demonstrated in figure 3 below.

Figure 3: Claim Frequency by Year of Construction



Source: (IBHS 2007)

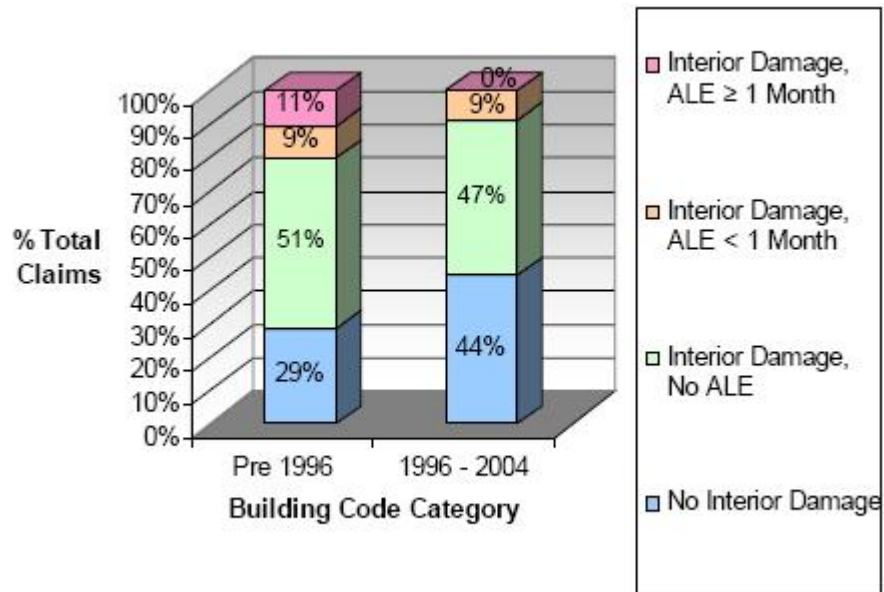
Figure 4: Average Claim Frequency by Building Code Category



Source: (IBHS 2007)

Findings also showed, as demonstrated in figure 4 above, that claims for homes built after the adoption of new building standards were 42 percent less severe when a loss did occur. In summarizing the effects that building codes had on reducing losses during Hurricane Charley, the study found that “the enforcement of modern engineering design based building codes made a positive impact on the performance of residential homes (IBHS 2007).”

Figure 5: Frequency of Interior Damage and ALE by Building Code Category



Source: (IBHS 2007)

Figure 5 above shows the reduction in additional living expenses that homeowners experienced following the enforcement of building codes. More information on this study and others can be found on the website of the Institute of Business and Home Safety at www.disastersafety.org.

Jaffee, Kunreuther, and Michel-Kerjan (2008) discuss the use of long-term insurance (LTI) in place of the standard annual homeowners policy. The authors find that social welfare should increase from a reduction of insurers' administrative costs as well as lower search costs and provide incentives for long-term investment in mitigation measures.

Grossi and Kunreuther (eds.) (2005) provide answers to the question of how to scientifically evaluate catastrophic risk. The authors analyze the use of catastrophe modeling in setting premiums for different types of risks as well as implementing government standards and

regulations to lessen risk and reduce losses. It is noted that in particularly well-developed countries, society as a whole fails to prepare for major natural disasters and instead takes action after the catastrophe has occurred.

In the article titled “Earthquake risk looms in Midwest,” Kristin Gunderson Hunt (2008) looks at the earthquake risk in the Midwestern States and their reluctance to implement structural changes to buildings and infrastructure in order to make them earthquake-ready. These Midwestern States are not often affected by earthquakes, but are still on a major fault line which puts them at risk. The author compares the slow conversion to earthquake-ready building codes and regulations in these states to the rapid implementation that took place in California.

Kovacs and Kunreuther (2001) examine experiences with natural hazards in both Canada and the United States. The authors discuss and suggest a framework for which to reduce the losses attributed to weather related natural disasters. This framework is based on issues that have arisen from previous experiences with catastrophic risk management and includes disaster prevention, emergency response, and community recovery. The public and private sectors’ catastrophic risk management policies in both Canada and the United States are reviewed in a comparison. The authors find that private insurance is a catalyst for reducing losses, but do not discount the importance of active involvement by the public sector.

Smolka (2006) discusses the ever-growing costs of natural disasters around the world. The increase in losses comes as the result of further development in coastal areas, increasing values, increase in world population, high vulnerability of modern societies and technologies, and changes in the natural environment to name a few. The results of continuous coastal development have been witnessed in recent years by the extreme losses of the 2004 tsunami and Hurricane Katrina in 2005. All of these factors will continue to drive up the loss numbers and

thus present a need for action. The author examines four elements to risk management which are risk identification, risk evaluation, risk control, and risk financing.

Smolka (2006) defines risk as a combination of three components. The first component is the hazard which is the likelihood of the occurrence of an event of a specified minimum size. The second component is the vulnerability of objects exposed to a hazard. This vulnerability “is expressed as the expected average loss as a percentage of the replacement value and is a function of the pertinent hazard parameter” which leads to the third component consisting of the value of objects exposed (Smolka 2006). The author finds that there must be a collaboration and cooperation of all the parties involved in order to cope with future loss burdens.

The parties involved can be separated into five groups that include the insured person or entities, primary insurers, reinsurers, capital markets, and governments/public authorities. These five parties must take responsibility for completing their own tasks to help with managing the risks associated with natural disasters. A change in focus by these groups must take place in order to funnel investments to more of a pro-active strategy which will help to reduce and prevent future losses (Smolka 2006).

Those that are insured can do their part by properly maintaining and securing sensitive items. There must be a certain portion of the financial risk undertaken by the insureds to maintain urgency and awareness of loss prevention in light of a natural disaster. This financial responsibility can be achieved through deductibles as a percentage of the sum insured or with coinsurance that obligates the insured to have a participation percentage in every loss. Primary insurers hold the responsibility “to provide and secure capacity by charging technically adequate rates, applying appropriate underwriting guidelines, accumulation control and portfolio

management, establishing reserves for natural perils, and limiting their liability according to their financial strength (Smolka 2006).”

As the primary risk carriers in losses due to natural disasters, reinsurers need to balance risk over time and locations, provide technical support to the clients in rating considerations and the assessments of probable maximum losses, as well as control and limit liabilities. A supplement to reinsurance is capital markets which are types of alternative risk transfers established in recent years. CAT Bonds, swaps and weather derivatives must not be used in competition with reinsurance as they provide additional capacity for top-rank losses. The majority of alternative risk transfer programs have only been introduced in highly developed countries due to factors such as the complexity of the programs, transaction costs, and the requirement of mature insurance markets (Smolka 2006).

Smolka (2006) suggests that the state must only be used as a reinsurer of last resort in very rare cases where the private sector is unable to cover the losses or when risks are uninsurable. The state therefore plays a vital role in maintaining the legitimacy of the insurance market by providing incentive for investing in insurance. It is up to the state to promote the use of all private resources available as well as assist in making those private resources accessible to as many people as possible. The largest role of the state is in the areas of risk management and risk reduction. According to Smolka, in order to reduce losses, states should design and enforce land use and building regulations, secure the serviceability of critical facilities and infrastructure, develop and coordinate emergency plans that specifically define the responsibilities of all authorities involved.

There is an increasing use of natural disaster insurance which is being included as a precondition of loans as required by mortgage banks. Problems persist with the implementation

of programs that promote the use of disaster insurance as people tend to be unaware of the available insurance mechanisms. There is also a sense that insurance is not necessary because the government will step in and fund the losses that are not covered by the resources of the private sector. The insurance sector does not actively promote prevention and mitigation measures due to intense competition as well as the length of time it takes for possible positive outcomes which contradicts their short-term financial perspective (Kunreuther et. al 2008).

In an article titled “When Disaster STRIKES,” Richard Kinchlea, the City of Hamilton’s community emergency management coordinator, spoke of the importance of governments developing programs in order to protect critical infrastructure during times of disaster. The speech covered the possible domino effect of catastrophes, citing the New Orleans levee system breaking in 2005 causing catastrophic floods following Hurricane Katrina, and the importance of focusing on service delivery as a preparation instead of solely physical assets.

Kunreuther and Pauly (2006) focus on multiple options for pre-disaster programs in order to prevent the extreme costs that often come as a result of poorly-managed expenditures following a natural disaster. The authors explore the lack of interest in insurance and mitigation prior to disasters as well as the reality that large losses do occur; therefore the appropriate protection against the risk should be taken. It is discovered that mandated comprehensive disaster insurance for all homeowners could serve as an alternative program to the current one since individuals do not voluntarily protect themselves against the possibility of natural disasters.

Twigg (1999) observes the benefits of community-based disaster management such as the ability to identify local problems more accurately. Community-based disaster management reduces vulnerability to disaster by providing knowledge to locals within the community on

effective mitigation and response procedures. Therefore, communities are presented with a cost-effective, fair and much more rapid emergency response.

Kunreuther, Orth and Roth (1998) observe a dramatic increase in insured losses from catastrophic events. The book gives suggestions to help provide funds for those affected as well as to reduce the amount of future losses.

Freeman et. al (2003) observe case studies from Latin America and the Caribbean and deliver an extensive literature review on disaster risk management systems around the world. The authors look at ways to improve disaster risk management systems and the financing that comes along with natural disasters with an emphasis on prevention and mitigation. The authors discuss the parties involved in disaster risk management as well as the components which form the two key elements of risk management: pre-disaster phase and post-disaster phase. The study analyzes instruments that can be used for financing the reconstruction following natural disasters and compares the differences in systems that are under centralized, government-directed management with ones which are localized and decentralized. Disaster risk management systems are investigated in various countries from South America, Central America, North America, Asia, and Europe.

Carter (1992) discusses the approach of a country to disaster risk management. It concludes that there must be a formal system in order for natural disaster systems to succeed in being comprehensive. Therefore, national governments must be actively involved in the interactions of institutions, financial mechanisms, regulations, and policies that make up the approach to disaster risk management of a country.

Albala-Betrand (1993) takes the opposite viewpoint of Carter (1992) in the discussion of disaster risk management. The author concludes that local concerns and initiatives are not taken

into consideration when natural disaster policies are focused around national governments. Therefore, nongovernmental organizations and community-driven projects are essential in the reduction of natural hazard risk and should be an integral part in the approach to disaster risk management.

Impacts of Governmental Policies

Governments on both local and national levels play a vital role in dealing with catastrophic risks and implementation of mitigation measures that will allow for a reduction of losses that come as a result of a natural disaster. In focusing primarily on the United States, Kunreuther et. al (2008) finds that “state governments play a critical role in establishing building codes and assuring these standards are effectively implemented.” Studies by the Insurance Information Institute following the devastating Hurricane Andrew in 1992 suggest that building code compliance and enforcement could have reduced insured’s losses by 25 percent.

Local governments are responsible for sufficiently staffing and appropriately training individuals in order to ensure adequate code enforcement. As an example of how this is often overlooked, the authors looked at the enforcement of building inspections in Dade County prior to Hurricane Andrew. It was revealed that the insufficient number of inspectors would have had to each inspect an average of 35 inspections per day in order to comply with state regulations requiring multiple inspections on new buildings each year. This number of inspections per day is considered to be virtually impossible considering the extensive tasks involved in each inspection (Kunreuther et. al 2008).

State governments have control over land-use and can prevent construction in areas that are consistently battered by natural hazards (Kunreuther et. al 2008). Construction in these areas

should only be allowed with restriction of federal funding following a catastrophe to those who choose to take on the risks of an area highly exposed to specific natural hazards. It is also the state governments which regulate primary insurers by way of solvency regulation along with rate and policy form regulation. Local governments are responsible for making sure that insurers and reinsurers are solvent enough to cover potential catastrophic losses witnessed by their policyholders. These governments also regulate the price and terms of the insurance contract provided by insurers (Kunreuther et. al 2008).

In situations where private insurance and reinsurance is unable to carry the load of a catastrophic event, local governments have “created and operated catastrophe insurance programs following large-scale disasters (Kunreuther et. al 2008).” Creations such as the Citizens Property Insurance Corporation in Florida and Louisiana act as stand-alone insurance companies in order to supplement the private sector. These state sponsored programs like the California Earthquake Authority have come about as a result of large catastrophic events such as the 1994 Northridge earthquake in California which cripple insurers and often keep them from selling new homeowner’s policies in the affected areas. The state government in Florida, for example, has also created state run facilities such as the Florida Hurricane Catastrophe Fund (FHCF) which “reimburses a portion of insurers’ losses following major hurricanes” as well as “provides reinsurance for personal and commercial residential properties (Kunreuther et. al 2008).” Another state run facility is the Florida Insurance Guaranty Association (FIGA) which backs the claims of insurers that become insolvent. Therefore, state governments play a major role in mitigating losses as well as supporting the insurance industry in hopes to reduce future losses from catastrophic events (Kunreuther et. al 2008).

The federal government plays a larger role in the disaster relief funding following the occurrence of a natural disaster. Low-interest loans, grants and tax benefits are available from the federal government to those individuals or small businesses that are not insured or are underinsured. The same federal relief is also made available to those cities and local governments in need of financial assistance. Special assistance is given to states upon declaration of a “major disaster” by the President. The President cannot declare a major disaster until a request has been turned in by the governor of the state. The House and Senate then determine the amount of aid that will be made available for the local governments to use in assistance with the severely damaged areas (Kovacs and Kunreuther, 2001).

A large burden is placed on the governments of countries that find themselves in the midst of a catastrophe. Governments around the world increasingly have to deal with the rise in incidences and severity of natural disasters. This has become a concern for governments as they are faced with the financing of disaster relief, reconstruction, and rehabilitation. Governments must make allocations for relief and reconstruction efforts following disasters which results in a negative impact on the countries’ macroeconomic stability (Kovacs and Kunreuther, 2001).

Even though insurance and the private sector usually cover the majority of damages to homes and businesses as a result of catastrophic events in most developed countries, the government and public sector must still account for damages to all public structures including schools, hospitals, and bridges. Thus, the problem arises from a lack of insurance on these public structures as the majority of public structures in the United States are not covered by insurance for catastrophic damage. This comes in large part as a result of budget constraints and local governments feeling that catastrophic disasters will not happen to their cities. Local governments are given little incentive to invest in protective measures and therefore do not,

because of the fact that the federal government in the United States will cover the losses from catastrophic events. The federal government will fund at least 75 percent of the costs associated with rebuilding and repairing public facilities due to natural disasters. In the case of a natural disaster that results in a catastrophic event, the federal government will fund 100 percent of the costs. For example, the entire cost of repairing public facilities was funded by the federal government after Hurricane Andrew in 1992 and the Mississippi floods of 1993 with some 90 percent being funded following the Northridge earthquake in 1994 (Kovacs and Kunreuther, 2001).

This is not exactly the case with the federal government of Canada which has set up the Disaster Financial Assistance Agreement. This agreement makes public relief unavailable to those property owners that do not take advantage of and invest in affordable and available private insurance. In the event of smaller natural disasters, the agreement does not allow for national disaster assistance. Even with the stipulations of the agreement, the Canadian government still covered the majority of losses from the 1998 Ice Storm and could potentially fund up to 90 percent of the costs from a catastrophic event (Kunreuther and Kovacs, 2001).

An article published by the Wharton Risk Management and Decision Center (January 2006) called “Hurricane Katrina: Important Policy Questions Amid the Devastation and Recovery” discusses the redevelopment of New Orleans following Hurricane Katrina and the problems with developing the land in hazard-prone areas. The article also covers the concept of a “moral hazard” caused by federal and local governments coming to the aid of disaster victims and therefore resulting in no consequences for their decision to rebuild or go without insurance.

Burby et. al (1999) conclude that the federal government of the United States has failed to take the necessary steps in order to minimize catastrophic losses from natural disasters. In

particular, there has been a failure to plan and manage the local land use in order to reduce risks. Instead, the government has subsidized development and movement to risky areas.

Burby (2006) investigates two paradoxes where the federal government increases losses by trying to make hazardous areas safer, as well as local officials not paying adequate attention to policies that limit vulnerability. The author suggests that local governments can minimize catastrophic losses through comprehensive planning that pays attention to hazard mitigation by increasing incentives.

Kydland and Prescott (1977) find that discretionary policy does not always result in socially optimal policy in the long run even though it may be most advantageous in the current situation. The authors give an example of this position in considering individuals which are allowed to live in a flood plain and do so under the assumption that the Corps of Engineers must build sufficient dams and levees to protect them as long as enough people choose to live in that area. At this point, the officials are presented with major political difficulties in trying to remove people from these types of areas and subsequently must invest in flood control projects to cope with the current situation.

Richard Kinchlea, the City of Hamilton's community emergency management coordinator, spoke of the importance of governments developing programs in order to protect critical infrastructure during times of disaster.

Burby and Holway (1993) find that local land use planning and controls would assist governments in reducing flood losses. The study suggests that being more aware of the large amount of development taking place in flood-hazard areas and slowing this development down could lead to a reduction in future flood losses.

The Wall Street Journal article titled, “Venezuela’s Chavez Attacked for Lax Reaction to Floods---Politics Blamed in the Aftermath of Lethal Disaster,” discusses the Venezuelan government putting politics first and not warning the people about flooding and mudslides which were imminent. The warning came out of a disaster after more than 90,000 people had already been affected. Two weeks prior to the warning being let out by the government, local news had reported numerous accounts of flooding and landslides all over the coastal region. The risk was present and no evacuation was ever ordered. Incidents such as this demonstrate just how important a country’s government plays in reducing losses from catastrophic events.

Kunreuther (2001) finds that cost-effective mitigation measures as well as insurance should be invested in for public structures in order to reduce the extreme costs to taxpayers following natural disasters. In order to ensure that municipalities implement cost-effective mitigation measures, Kunreuther suggests that legislation be changed so that recovery funds are not made available to those local governments which failed to implement the measures. The author gives an alternative form of insurance that the government could take which is a community-based form of insurance. Here the government covers losses to public structures by levying property taxes on all residents of the community.

In the way of recovery management in developing countries, Hagiwara and Sugiyarto (2005) suggest that governments should speed up recovery by committing to sound macroeconomic management. This is due to the negative effect that a longer recovery time has on a developing nation’s economy. The Indonesian government set up an independent authority called the Specific Authority Board for Aceh Reconstruction in Indonesia which enabled better implementation of programs allowing for a faster recovery. Independent authorities, such as the one in Indonesia, deliver assistance with the use of recovery funds to developing nations. A key

component in the recovery process is the contributions of local governments as they are able to prioritize programs that are most needed. On the local level, needs can be better identified and presented with more specificity to help generate employment and regain a community's infrastructure.

In poorer countries, governments may have to change urban and housing policies in order to prevent large numbers of poor citizens with subpar housing from settling in hazard zones.

There also must be an enforcement of tougher building standards as the building standards and land-use planning have been poor in areas where urbanization is rapidly taking place.

Development can also be directed away from coastal areas in order to reduce the higher vulnerability of people and property. There can be synergies built between policies and programs which reduce disaster risk and at the same time support development efforts.

Investments made to improve the communications and transportation infrastructures will not only boost the economy due to everyday purposes, but also facilitate a country in the event of a natural disaster. Along the same lines are improving community disaster preparedness programs which attribute to the building of social networks within communities. Microcredit programs are another way to achieve two objectives at once by contributing sustainable livelihoods for the poor as well as help those same people back on their feet following a catastrophe (Hagiwara and Sugiyarto 2005).

Krimgold and Vatsa (2000) conclude that in order to achieve effective risk management governments and communities must be strengthened with knowledge of hazard mitigation alternatives as well as the implementation of mitigation measures. The authors also suggest that "capacity building is accomplished through public policy interventions, investment at national and community levels, and mitigation incentives (Krimgold and Vatsa 2000)." Therefore,

delivering major responsibilities to governments around the world in creating public policy will result in a reduction of risk and vulnerability and lead to a reduction in losses from disasters (Krimgold and Vatsa 2000).

Impacts of Outside Organizations and Agencies

There are many organizations that have contributed and continue to contribute to the needs of countries during times of disasters. These organizations aim to offer relief for those in need as well as provide the leadership necessary for developing countries in assistance with issues during the response and recovery. Organizations such as the World Bank, International Red Cross, United Nations, World Health Organization, Asian Development Bank, and Médecins Sans Frontières have begun to gain interest in programs that allow for better prevention and mitigation against catastrophic events.

Organizations flock to regions after a disaster occurs, such as those coastal areas severely affected by the 2004 tsunami, in order to support and restore the livelihoods of the communities in need. In order to present a long-term plan that will rehabilitate the agriculture and fisheries industries which was badly impacted by the tsunami, The WorldFish Center has led an initiative of the Consultative Group on International Agricultural Research in the tsunami-affected regions. The initiative will organize and manage a large group of contributors in order to produce and implement plans that reduce future disaster risk while promoting sustainability. The coalition of contributors includes donors, research and government agencies, other nongovernmental organizations, and civil society (Freeman et. al 2003).

Many other nongovernmental organizations such as the World Bank, the International Institute of Applied Systems Analysis and the Swiss Reinsurance Company have come together

to form a partnership. This particular partnership was formed in order to create and provide a tool that demonstrates the potential for a natural disaster to have a catastrophic impact on the long-term development of a country (Freeman et. al 2003). Partnerships such as this have been formed in hopes to aid developing countries in their battle to reduce future losses from catastrophic events before these events occur.

Burton and van Aalst (1999) express the World Bank's interest in having disaster planning be a part of the country assistance strategy level. Disaster planning would then be incorporated "as part of the benefit/cost analysis at the project approval level (Burton and van Aalst 1999)."

A drawback of the international donor community is the fact that while there has been a recent push for organizations to focus on disaster preparedness, the actions and timetables were never set in order to implement such risk reduction measures. The international community stands much more prepared to respond and recover from natural disasters after the fact than to invest in disaster preparedness and preparation before a disaster occurs. This could pose a problem as losses continue to increase in large part due to a lack of mitigation measures being implemented (Fritschel 2005).

The 2004 briefing by the Department for International Development reports that although outside organizations undoubtedly save many lives and relieve suffering all around the world, humanitarian programs may have negative impacts on the long-term resilience of developing countries following a disaster. The briefing suggests that this is a result of organizations taking over and may actually "sideline local leadership, governance and technical capabilities" that are essential for the long-term stability of the country (DFID 2005). An important part in the recovery of a nation following a catastrophe is not only short-term strategy that many outside

organizations focus on, but also the long-term needs in sustaining lives and restoring livelihoods (DFID 2005).

A study by Benson and Twigg (2004) finds that aid agencies currently use many tools that could actually be used by countries in order to assess disaster risk. These tools presently design projects for multiple aid agencies and could possibly be of use in a variety of appraisals such as economic, environmental, and social appraisals. They can also conduct a multitude of analyses on risk and vulnerability along with logical framework analyses. These analyses can then be used in order to measure the social, environmental, humanitarian, and financial costs and benefits of implementing various mitigation measures.

The Role of Data

One outside agency that plays a large role in the research on impacts of natural disasters worldwide is the Centre for Research on the Epidemiology of Disasters (CRED). CRED collects data on natural disasters and their human impact from a multitude of sources including research institutions, press agencies, UN agencies, non-governmental organizations, and insurance companies. This data is put into the EM-DAT database and made available to the public at www.cred.be. The EM-DAT database consists of data based on the occurrence and effects of natural disasters from 1900 to present and is entered into the database providing that one of four criteria be met. The criteria for disaster data to qualify for the database include 10 or more people reported killed, 100 people reported affected, declaration of a state of emergency and/or a call for international assistance. Direct damages to crops, housing and infrastructure are solely reported in the database, thus excluding any and all indirect damages.

Two of the world's largest reinsurance companies Munich Re and Swiss Re also have developed highly sophisticated databases. Munich Re's NatCat and Swiss Re's Sigma provide little information on natural disasters in countries with low insurance density resulting in an absence of data for Asia, Africa and Latin America. Neither of the two databases is fully accessible by the public. Data from natural disasters is vital in the reduction of future losses as it can be used not only for research, but for "analytical tools to help prioritize international action to reduce disaster risk (IFRC 2005)."

The fourth international disaster database is known as DesInventar which is based in Latin America and the Caribbean, but also has sub-national databases in the U.S., Brazil, Colombia, South Africa and India. DesInventar is managed by a group of non-governmental actors and "specializes in local records of disaster loss and presents national disasters through local loss data (IFRC 2005)." A common problem with data collecting in all four of the international databases is that standard definitions that are needed to effectively organize the data are lacking. Disaster data has greatly improved over the last 20 years as the World Disasters Report 2005 points out, but there are still numerous challenges such as defining hazards and distinguishing events, the absence of standard guidelines for local disaster data and public accessibility to the data (IFRC 2005).

CHAPTER 2

LEARNING FROM NATURAL DISASTER EXPERIENCE

Hurricane Katrina 2005

The Storm and Impacts

The results of continuous coastal development have been witnessed in recent years by the extreme losses experienced in the Gulf Coast of the United States from Hurricane Katrina in 2005. The storm not only caused extreme losses along the Gulf Coast, but also demonstrated the “potential worldwide implications of natural disasters by the severe shortage in oil-producing and refining capacities and the ensuing sharp price increases in the global oil market (Smolka 2006).”

The Category 3 storm made landfall around 6 a.m. on the morning of August 29, 2005 near Buras, Louisiana, which is 65 miles southeast of New Orleans. Damage was extensive throughout the impacted areas of Alabama, Mississippi and Louisiana as costs to the U.S. economy have been estimated to be as high as \$200 billion. Following the levee breach, 80 percent of New Orleans was inundated with water from Lake Pontchartrain. The storm and flooding that ensued resulted in major property damage along the gulf coast estimated at a total of almost \$100 billion as seen in table 1 below (The Federal Response to Hurricane Katrina: Lessons Learned 2006).

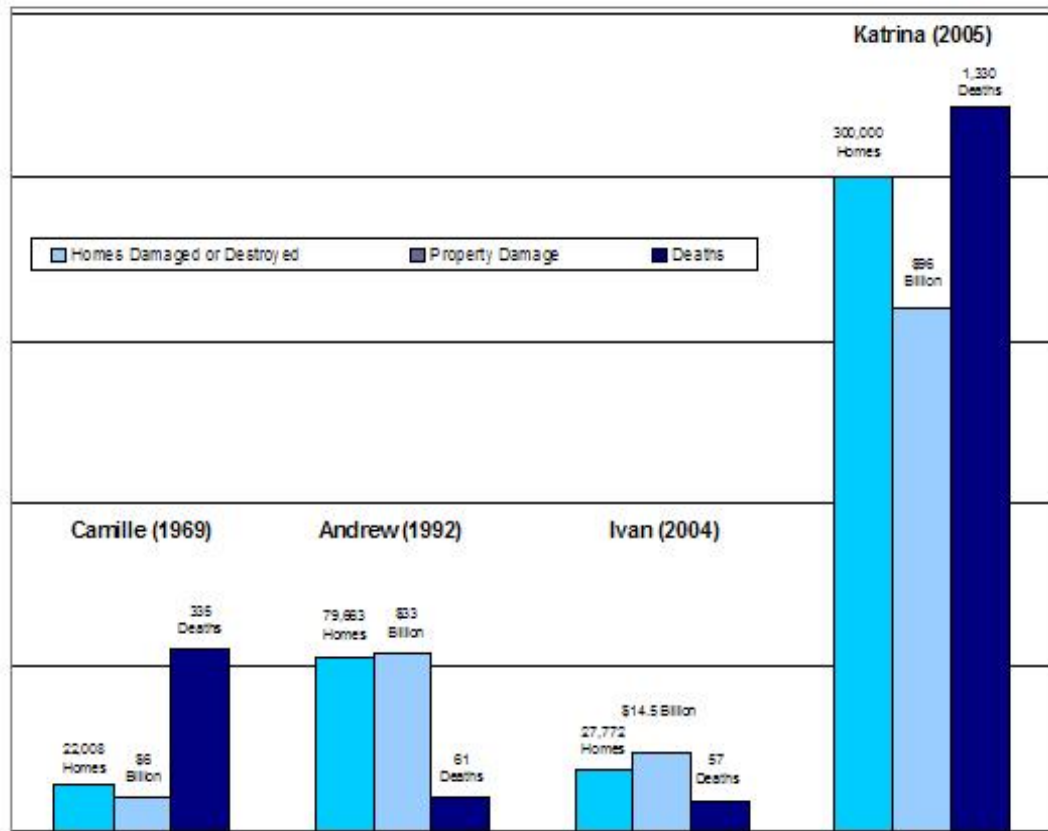
Table 1: Estimated Property Damages From Hurricane Katrina and New Orleans Flood

Housing	\$67 billion
Consumer Durable Goods	\$7 billion
Business Property	\$20 billion
Government Property	\$3 billion
Total	\$96 billion

Source: (The Federal Response to Hurricane Katrina: Lessons Learned 2006)

Hurricane Katrina became the one of the worst natural disasters in United States history by killing 1,330 people and destroying some 300,000 homes. As of February 17, 2006, there were still 2,096 people from the region reported as missing with some 770,000 people being displaced from their homes. In all, debris amounts from the area totaled 118 million cubic yards which consisted of homes, buildings, forests, and green spaces. The 118 million cubic yards was much more debris than the 20 million cubic yards left behind by Hurricane Andrew. As seen in figure 6 below, Hurricane Katrina was incredibly more devastating than three of the worst hurricanes to hit the U.S. in recent history.

Figure 6: Comparison of Hurricane Katrina with Hurricanes Ivan, Andrew and Camille



Source: (The Federal Response to Hurricane Katrina: Lessons Learned 2006)

Property damage was just one of many costly concerns following the storm as “Katrina’s wrath went far beyond wind and water damage (The Federal Response to Hurricane Katrina: Lessons Learned 2006).” The catastrophic storm caused multiple oil spills along the gulf coast resulting in over 7.4 million gallons of oil being dispensed into the region’s waterways. There were at least 10 oil spills caused by Hurricane Katrina that were reported in Louisiana; 6 of which were major spills of over 100,000 gallons and 4 being medium spills of over 10,000

gallons. In all, the oil spilled as a direct result of the storm was more than two thirds the amount that was released off of the Alaskan coast in the case of Exxon Valdez in 1989.

The effects of Hurricane Katrina on the U.S. economy were witnessed in large part by the rise in gas prices around the country. Although the full effects of the storm were not yet witnessed in February 2006 when the White House released a review of the lessons learned from Hurricane Katrina, short-term effects were felt as many crude oil and natural gas production centers in the Gulf of Mexico were temporarily shutdown as the storm approached the coast. This temporary shutdown led to a sharp rise in gas prices immediately following the disaster. Combined with the landfall of Hurricane Rita between Texas and Louisiana on September 24, Hurricane Katrina left 114 million barrels of oil production capacity unused between August 26, 2005, and January 11, 2006. This amount of oil production is equal “to over one-fifth of yearly output in the Gulf of Mexico (The Federal Response to Hurricane Katrina: Lessons Learned 2006).” The rise in gas prices was simply a short-term “economic ripple” that spread throughout the country, while much greater affects were felt in the local economy. For instance, the unemployment rate rose from 6 percent up to 12 percent between August and September in those areas most affected in Louisiana and Mississippi. There was dramatic decrease in salaries and wages which fell approximately \$1.2 billion in the third quarter of 2005 in Louisiana, Mississippi, and Alabama (The Federal Response to Hurricane Katrina: Lessons Learned 2006).

The Problems and Response

Crocco and Grolnick (2007) discuss the breakdown in communication between government officials including the mayor, governor and FEMA director and the some 1,700 lives lost as a result. Approximately 15 percent of the police force abandoned their posts leaving New

Orleans unprotected from looters and other criminal acts. Hurricane Katrina brought about awareness of the possibilities of failures in levee systems throughout the United States and led to an investigation by the Army Corps of Engineers. This investigation revealed that over 120 levees in various states throughout the country were in danger of failing. This problem with the levees around the country can be attributed to the same problem as was seen with the ones in New Orleans that senior regional officials of the Army Corps of Engineers had been complaining about publicly for years; the levees are “chronically underfinanced (Crocco and Grolnick 2007).”

Meyer (2006) focuses on the problems experienced in New Orleans with risk management. The author points out that New Orleans did not learn from the warning just one year before Hurricane Katrina with Category 5 Hurricane Ivan that eventually proved as a false alarm for the area. Though Hurricane Ivan did not make landfall in New Orleans, large-scale evacuations were executed that revealed many of the same problems in the preparedness procedures experienced during Katrina. A disaster exercise with a hypothetical hurricane was also executed not long before the storm. This preparation procedure was eerily similar to the scene that was actually witnessed during Katrina as hypothesized 87 percent of the city underwater as a result of breached levees compared to the actual 80 that occurred following the real storm. The author suggests that “Hurricane Katrina was a case study of these weaknesses: opportunities to learn from experience went unexploited, mitigation measures with long-run benefits were under-funded, and the principals emerged as both overconfident before the event and overmatched afterward (Meyer 2006).”

Meyer (2006) discusses the human nature of learning and presents the idea that less feedback is available as one invests more and more into mitigation measures. The increased investment in mitigation measures causes a reduction in the experience of losses. A domino

effect occurs as the experience of loss is reduced and investments in mitigation seem to become useless “because the decision maker cannot observe the counter-factual of what would have happened had a mitigation investment not been made (Meyer 2006).” Meyer gives the underfunded levee system and other flood control projects as an example of this costly way of thought.

Brinkley (2006) observes the destruction of Hurricane Katrina on the Gulf Coast as 150 miles of coastline were destroyed by the Category 3 storm. Although much of the attention is paid to New Orleans and the devastation left behind due to failure in the levees, many cities along the Gulf Coast bared witness to extremely severe damage. The author describes New Orleans in particular as a disaster waiting to happen. The system of levees and pumps were only considered to be able to withstand a “fast-moving Category 3 storm (Brinkley 2006).” There was not a single shelter certified by the Red Cross in New Orleans as the nonprofit organization does not open shelters in flood zones. Therefore the organization, which is instrumental in disaster relief efforts, would not open as a result of all likely buildings for shelter use being located at or below sea level.

Brinkley (2006) reveals that in 2004, some 270 government officials participated in a simulation that demonstrated the destruction which could be expected to occur in the city of New Orleans upon the landfall of a Category 3 storm. The FEMA-funded program resulted in a computer generated simulation that had the city under 10 feet of water with hundreds of thousands of people stranded. This was supposed to prepare government officials for the real possibilities of a major catastrophe, and prepare the city for massive evacuations of citizens using school buses starting 72-hours prior to the storm. The problem came when the mayor ignored FEMA guidelines and failed to prioritize hurricane evacuation plans. Despite

approximately 112,000 citizens in the city without cars, there was “no comprehensive plan to evacuate vulnerable people” implemented (Brinkley 2006).

The people in New Orleans were extremely vulnerable with 27.9 percent of the population living below the poverty line in 1999. Another problem arose just two days before the storm with the director of the Federal Emergency Management Agency which did not send emergency-response management teams to the region following a briefing on the increasing likelihood of a direct hit on New Orleans. Even further communication errors were encountered from Baton Rouge to the White House as stated by former Washington State legislator Bob Williams in a Wall Street Journal article when he said:

President Bush declared an emergency prior to Katrina hitting New Orleans, so the only action needed for Federal assistance was for Governor Blanco to request the specific type of assistance she needed. She failed to send a timely request for specific aid. In addition, unlike the governors of New York, Oklahoma, and California in past disasters, Governor Blanco failed to take charge of the situation and ensure that the state emergency operation facility was in constant contact with Mayor Nagin and FEMA (Brinkley 2006).

Even though the city was sluggish in the evacuation, surrounding universities and business were closing down, boarding up and making sure that people were getting out of town. The governor oversaw a “contra-flow” evacuation plan which turned all lanes of traffic outward on four interstate highways. There was a false sense of invisibility for many people in New Orleans prior to the storm due to the fact that the large storms seemed to steer away at the last moment. This was exactly the case in 2004 when Hurricane Ivan was headed for New Orleans, but veered away before making landfall.

This near miss gave some citizens and government officials a false sense of security as they had not seen the destruction that could be caused first hand (Brinkley 2006).

A mandatory evacuation was announced just 48 hours before the storm, but by that time “it was unfortunately not enforceable (Brinkley 2006).” This left one-fifth of the city’s residents in the city as well as a similar proportion in surrounding suburbs. By the time the mandatory evacuation in the city of New Orleans had been issued, many officers had already fled the city making it virtually impossible to remove people from the city. The government’s mis-management of Hurricane Katrina proved to be just as deadly as the storm itself. Thousands of people died due to the lack of communications between the mayor, governor, and FEMA director. Brinkley provides further examination into the governmental failures on every level that plagued the city of New Orleans and its people (Brinkley 2006).

In the fall 2006 issue of the Harvard International Review, Howard Kunreuther reviewed the risk and responses in the case of Hurricane Katrina. Kunreuther reviews the feeling that individuals and decision makers have of disasters not happening to them. The article also suggests that challenges arise from the nature of interdependencies.

Kunreuther (2006) looks at the disaster of Hurricane Katrina and finds that the extremely elevated costs associated with the catastrophe provide evidence of the natural disaster syndrome. This was due to many individuals suffering severe losses from flooding as a consequence of not having flood insurance coverage and therefore, not having their homes properly mitigated against risk. In the case of Katrina victims, an extraordinary amount of federal disaster assistance has been promised to such individuals. Kunreuther points out that individuals not only feel that events such as Katrina will not happen to them, but also have a false sense of

security from measures, like levees, taken to protect the areas from disaster. The author concludes with the position that private and public sectors must work together in order to reduce future losses from natural disasters and simultaneously limit government assistance following the disaster.

A conversation, published by the Wharton Risk Management and Decision Center (October 2005), with Morris A. Cohen, Lawrence G. Hrebiniak, and Robert E Mittelstaedt, Jr. debates the lack of leadership from the federal government in response to Hurricane Katrina. The question and answer session covers the role of the government, ways in which the government failed in New Orleans, and lessons that can be learned from the disaster (Cohen, Hrebiniak and Mittelstaedt 2005).

An article published by the Wharton Risk Management and Decision Center (November 2005) called “Picking Up the Pieces From Katrina: What Lies Ahead” observes the economic damage that the United States witnessed from Hurricane Katrina. The article also provides a European perspective on the possibilities of the economic impact of Katrina to carry over to the world as compared to the 1998 Hurricane Mitch that devastated Latin America, yet had very little impact on the world.

Kunreuther et al. (2008) find that Hurricane Katrina elevated the controversy over the wind/water coverage of insurers. The argument on what portion of wind caused damage versus what portion of rising water was responsible arose as a result of extensive flooding and storm surge from the hurricane. This came about as standard multi-peril insurance policies usually cover damage from non-catastrophe perils such as fire, wind, hail lightning, winter storms and volcanic eruption. Flood damage as a result of rising water, on the other hand, is not covered through standard policies, but instead specifically excluded. Many homeowners throughout

Mississippi and Louisiana only had homeowners insurance and therefore were not insured against flood damage. As a result homeowners filed lawsuits against insurers following Hurricane Katrina, even though coverage from flood damage is available through the federal government's National Flood Insurance Program (NFIP).

Thus far, the courts have ruled in favor of the insurers with litigation still ongoing in numerous cases. Insurers have paid the price with rising court costs and have also "been reluctant to write new homeowners policies in these states, given the uncertainty of contract enforcement (Kunreuther et. al 2008)." The dilemma then arises as insurers face an increase risk of having to unexpectedly pay for flood damage. To account for the increased risk, insurers will have to increase rates which negate the purpose of the National Flood Insurance Program, which is run by the Federal Emergency Management Agency (FEMA). An increase in rates punishes those who have invested appropriately in both homeowners insurance and the NFIP by making them pay for "redundant coverage." The flood losses from Hurricane Katrina resulted in a financial crisis with the NFIP. Losses from storm surge and flooding were so substantial that the program borrowed \$20 billion from the United States Treasury (Kunreuther et. al 2008).

The Lessons Learned

In February 2006, Frances Fragos Townsend who is the assistant to the President for Homeland Security and Counterterrorism headed the study called "Federal Response to Hurricane Katrina: Lessons Learned." This study reveals facts involving the devastating storm and the response of the federal government. In the study, seventeen lessons learned are revealed and described. The lessons learned highlight the most critical challenges that reduced efficiency and effectiveness during the Federal response to Hurricane Katrina. The study tries to "identify

systemic gaps” in order to improve the preparedness for the next disaster. The lessons learned from the study “range from high-level policy and planning issues (e.g., the Integrated Use of Military Capabilities) to operational matters (e.g., Search and Rescue) (Federal Response to Hurricane Katrina: Lessons Learned 2006).” While some of the seventeen identified critical challenges had affects on various areas of the Federal response, others had impacts on very specific operational procedures. The study describes the importance of training, exercises, and lessons learned in order to better prepare for future disasters. In all, the lessons learned produced over 100 recommendations for corrective action which are outlined and detailed in this study.

The Current Situation

Significant progress has been made over the past three years throughout New Orleans and the Gulf Coast Region. With support from the Federal government and non-governmental organizations, local leaders have been able to drive the rebuilding effort and stimulate economic growth in the area. The Greater New Orleans metro area has seen the population increase to 87 percent of pre-Katrina levels with an increase of 8,600 jobs in the past year. There are currently more restaurants in the area than before Katrina with the number of visitors to the city almost doubling from 3.7 million in 2006 to 7.1 million in 2007. Visitor spending has also dramatically increased in the past year while rising from \$2.8 billion in 2006 to \$4.8 billion in 2007. The Federal government has contributed \$140 billion to the area including tax relief to help stimulate growth as well as take care of citizens’ vital needs. Of the \$140 billion, 81 percent has either been distributed or is currently available for States to withdraw. Some \$20 billion has been allocated to the largest housing recovery program in U.S. history (Federal Response to Hurricane Katrina: Lessons Learned 2006).

Repairs were completed by the U.S. Army Corps of engineers in June of 2006 to the 220 miles of floodwalls and levees that were damaged by the storm. Improvements to the levees continue to be made as the Corps is on track to complete its goal of 100-year protection by 2011. These improvements have been made possible by the \$12.85 billion appropriated by the Federal government since 2005 in order to repair and strengthen the levee system. The Federal government has also concentrated on funding the repairing and strengthening of public infrastructure by contributing \$12.1 billion to the cause, of which \$11.1 billion has been made available to the states for withdrawal (Federal Response to Hurricane Katrina: Lessons Learned 2006).

Economic development has been stimulated through various programs such as the disbursement of nearly \$6.5 billion in low cost disaster loans by the U.S. Small Business Administration as well as the Presidential and Congressional approval of “\$13.8 billion in tax incentives and relief for hurricane victims and small businesses through the Katrina Emergency Tax Relief Act and the Gulf Opportunity Zone Act (Federal Response to Hurricane Katrina: Lessons Learned 2006).” Other stimulus programs have included providing \$250 million to farmers by the U.S. Department of Agriculture, \$418 million granted by the U.S. Department of Labor for creation of temporary jobs and development of workers, and the closure of 99 percent of all National Flood Insurance Program claims. The NFIP has therefore provided citizens of Louisiana \$13.5 billion in assistance and \$2.47 billion in assistance to residents of Mississippi (Federal Response to Hurricane Katrina: Lessons Learned 2006).

A key aspect of the rebuilding and recovery effort along the Gulf Coast has been the tremendous support provided by faith-based and community nonprofit organizations. These organizations have been heralded and supported by the Federal government, which “awarded

more than 2,100 direct, competitive grants to faith-based and other nonprofit organizations in Gulf Coast states totaling more than \$1.8 billion” in 2006. Organizations such as the Nation’s Armies of Compassion have been a crucial part of the recovery with more than 93,000 participants in national service programs contributing over 3.5 million hours of service. Organizations have also received donations of more than \$3.5 billion for the recovery and reconstruction effort from American citizens (The Federal Response to Hurricane Katrina: Lessons Learned 2006).

Cyclone Nargis 2008

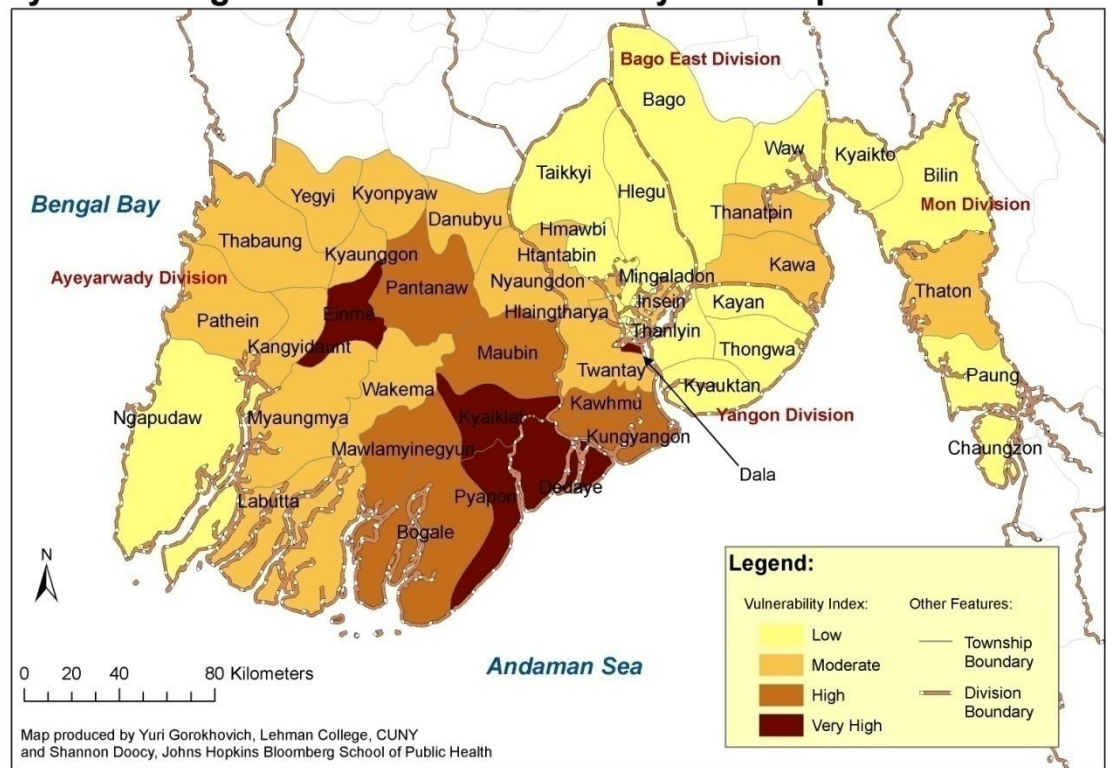
The Storm and Impacts

On May 2 and 3, 2008 Tropical Cyclone Nargis pounded the coast of Myanmar with wind speeds topping 190km/hr. Rated as the eighth deadliest cyclone of all time, it caused devastating damage to the entire coast of Myanmar with an official death toll of 84,537 and 53,836 people still missing as well as 19,359 people injured. There have been a reported 2.4 million people severely affected by the storm, which is approximately one-third of the country’s total population. Those 2.4 million people that have been considered “affected by the storm,” were done so due to their loss of livelihoods, shelter, or similarly severe loss. Myanmar bared witness to the worst natural disaster in its nation’s history and one of the most devastating to hit Asia since the cyclone that struck Bangladesh in 1991. An emergency effort of \$50.8 million was launched two weeks after the cyclone struck the coast (IFRC 2008b). The government of Myanmar initially declared the states and divisions of Yangon, Ayeyarwady, Bago, Mon, and Kayin as disaster areas, but later revised this list down to only the Ayeyarwady and Yangon divisions.

The most severe damage was witnessed in the delta region which had an estimated 95 percent of housing being destroyed by high winds and a large storm surge. The main method of transportation in this region is typically by waterway, but as a result of the significant damage produced by the storm, transportation was extremely limited in the region with the water transport infrastructure being severely damaged. Communication and power was disrupted, roads in and out of the area were impassible due to flooding and debris, and buildings were severely damaged in the Yangon area which took a direct hit from the deadly storm (Myanmar Tropical Cyclone Nargis Flash Appeal 2008). Figure 7 below demonstrates the estimated areas of Myanmar that were most adversely affected by the storm's impact based on the storm's path, the vulnerability of the area, and its population.

Figure 7: Myanmar's Most Affected Areas

Cyclone Nargis: Most Affected Areas by % of Population and Area



Source: (Cyclone Nargis: Most Affected Areas by % of Population and Area)

The Ayeyarwady Delta, which is a remote area that is heavily populated and difficult to access, was severely disrupted by the loss of lives and livelihoods. Perhaps most devastating to the region was the timing of the storm, which struck during the critical harvesting and planting season. In the Delta region, approximately 50-60 percent of families are engaged in agriculture due to ample water, relatively fertile soils, and rich aquatic life. The increased production led to an abundance of small businesses and traders before the storm (Myanmar Tropical Cyclone Nargis Flash Appeal 2008).

The Ayeyarwady Delta otherwise known as Myanmar's breadbasket region or the country's rice bowl was adversely affected by the category 3 storm's high winds and 12 foot storm surge. The cyclone blew ashore during the "dry season" crop, which is the very last stage of harvesting that accounts for 25 percent of the annual production in the affected area. Therefore, the storm destroyed a number of rice warehouses and their stocks resulting in the Ayeyarwady Delta losing a considerable amount of crops. The major crop in Myanmar is paddy which is typically planted in June or July. The storm destroyed and decimated the tools and seeds necessary for the paddy planting season and thus, "only 25 percent of villages along the affected areas reported having enough seeds (PNJA 2008)." About 16,200 ha³ of the standing summer paddy crop was reported damaged, which is the equivalent to 80,000 MT⁴ of production being damaged along with damage to an estimated 251,000 MT of paddy and milled rice in farmers' storage. The Delta region experienced the destruction of approximately 34,000 hectares of plantation crops that caused some K22 billion worth of damage to plantations (PNJA 2008).

There are many factors that the Post-Nargis Joint Assessment team has found will likely cause a significant amount of production losses in the future. The erosion and damage to paddy land, low viability of rice seed, loss of draught animals and farm equipment, farmers' inability to afford fertilizer purchases, and the reduced availability of labor were all factors that resulted in an estimated loss of crops from K160 billion to K283 billion. The reduced availability of labor arose due to home rebuilding requirements, out-migration of casual labor, and the large number of dead and also contributed to the soaring estimated losses. Foregone production losses have totalled an estimated K65 billion for just this year alone with tree crops generally taking between

³ Ha is a unit of area equal to 10,000 square meters.

⁴ Mt is a measurement of mass equal to 1,000 kilograms.

3-5 years to be re-established into production. As a result, “losses due to foregone paddy production are estimated at between 40-70 percent of pre-Nargis levels, or between 0.8-1.5 million metric tons (PNJA 2008).”

The agriculture sector, consisting of approximately 45 percent of the nations GDP in 2007 and one-third the regional GDP’s in the Ayeyarwady and Yangon Divisions, encompasses crops, plantations, livestock, and fisheries. Table 2 below shows the estimates of damage and losses experienced within the agriculture sector as a result of the cyclone.

Table 2: Estimates of Damage and Losses in the Agriculture Sector (Kyats million)⁵

	Disaster Effects			Ownership by Sector	
	Damage	Losses	Total	Public	Private
Field Crops	65,336	159,929 to 283,000	225,265 to 348,336	-	225,265 to 348,336
Farm Equipment	24,046	-	24,046	-	24,046
Plantations	22,043	65,209	87,252	-	87,252
Livestock	45,190	30,775	75,965	-	75,965
Capture Fisheries	25,609	99,932	125,541	-	125,541
Fish Farms	4,120	29,394	33,514	-	33,514
Total	186,344	385,239 to 508,310	571,583 to 694,654	0	571,583 to 694,654

Source: (PNJA 2008)

The total damage and losses estimated for the agriculture sector range from K570,000 million to almost K700,000 million. Foregone production for fisheries is expected to reach K130 billion while the total estimated damage in fisheries is around K 30 billion. These losses come as a result of damage to the fisheries infrastructure, post-harvest capabilities, and equipment. With

⁵ The table is a recreation of the one given by the Post-Nargis Joint Assessment with all estimations delivered in Kyats at an exchange rate of Kyat 1,100 per USD 1.

approximately 50 percent of the buffaloes and 25 percent of the cattle being killed in the storm as well as a high mortality among small livestock, losses to livestock have been estimated around K75 billion. The study suggests that these significant losses are “affecting many small and marginal farmers and landless agricultural workers (PNJA 2008).”

Overall damages to the economy of Myanmar appear to amount to an estimated 21 percent of the nations GDP. The majority of losses estimated by the Post-Nargis Joint Assessment Team are projected to occur in the present year with exceptions for the permanent plantations which take more than one year to recover. Nargis caused damages and losses amounting to an estimated K4,500 billion or USD 4,057 million in the affected areas of Myanmar. Damages are calculated by the destruction of physical assets while losses are a result of a reduction in economic activity following the disaster (PNJA 2008).

Table 3: Total Damages and Losses Summary Cyclone Nargis

Sector	Sub-Sector	Damage	Losses	Total	
				Kyats Billion	USD Million
Infrastructure		831.5	89.3	920.8	837.1
	Housing	686	25.9	711.9	647.2
	Transport and Communications	122	62.7	184.7	167.9
	Water Supply	8.1	0.4	8.5	7.7
	Electricity	15.4	0.3	15.7	14.3
Social Sectors		128	7.2	135.2	122.9
	Education	115.3	1	116.3	105.7
	Health	12.7	6.2	18.9	17.2
Productive Sectors		736	2,352-2,475	3,088-3,211	2,806-2,918
	Agriculture, Livestock, Fisheries	186.3	385-508	571-694	519-630
	Industry	512.5	1,483.50	1,996.00	1,814.5
	Commerce	37.2	483.4	520.6	473.3
Cross-Cutting Issues		234.2	46.1	280.3	254.8
	Environment	16.8	46.1	62.9	57.2
	Public Buildings	217.4	0	217.4	197.6
Total	In Kyats Billion	1,930	2,495-2,618	4,424-4,547	
	In USD Million	1,754	2,268-2,380		4,022-4,134

Source: (PNJA 2008)

Table 3 above delivers an overall summary of the damages and losses experienced from the disastrous cyclone. The table shows an estimated K1,930 billion in damages which accounts for 43 percent of the total effects of the catastrophe and an estimated K2,495 to K2,618 in losses that makes-up the other 57 percent of the total.

Cyclone Nargis is expected to have a modest macro-economic impact on the overall economy of Myanmar, and therefore should result in lower growth for the fiscal year 2008-09. Table 4 below shows the total impact on each sector resulting in losses that are estimated to total 2.7 percent of the officially projected national GDP in 2008. “The aggregate estimated loss in

value added in the current fiscal year (FY08) from the cyclone amounts to approximately K850 billion or USD780 million (PNJA 2008).” These losses are a result of the extreme impacts on the main area for agriculture production in the Ayeyarwady Delta along with heavy damage to assets, industrial production, and commerce in Yangon. The Yangon and Ayeyarwady Region experienced losses that are estimated to total around 11 percent of the region’s economy. The increase in relief and recovery expenditures along with capital expenditures for reconstruction is expected to increase the government deficit. The study suggests that the government’s primary means of financing the budget deficit is through money creation which should result in a significant impact on the government’s finances and budget deficit (PNJA 2008).

Table 4: Impact on GDP of Myanmar

	Nominal GDP 2008 Kyat Billion	Gross Losses	Value Added Coefficients	Value Added Losses	Impact on Sector/Total GDP
Agriculture	10,632	225	0.8	185	1.7%
Livestock and Fisheries	2,330	160	0.6	98	4.2%
Industry	5,130	1,362	0.2	239	4.6%
Commerce	6,708	461	0.7	334	5.0%
Total GDP	31,672			857	2.7%

Source: (PNJA 2008)

The Problems and Response

Myanmar is governed under the strict military rule led by Senior General Than Shwe. Prior to the disaster, the government of Myanmar established a National Natural Disaster Preparedness Central Committee, which was headed by Prime Minister General Thein Sein. The

committee met on the morning of the storm in order to prepare and implement plans for an immediate response to the disaster. There were 10 Emergency Disaster Response Sub-committees established that attended to the relief, recovery, rehabilitation, and reconstruction of those areas impacted by the storm. The 10 sub-committees included news and information, emergency communication, search and rescue, assessment and emergency relief, confirmation of loss and damage, transportation and route clearance, natural disaster reduction and emergency shelter provision, healthcare, rehabilitation, and reconstruction as well as security (PNJA 2008).

Immediately following the disaster, the government earmarked Kyats 50 billion or the equivalent to USD 45.45 million for relief and recovery efforts. This money was used to set-up relief and rehabilitation programs such as relief camps, field hospitals, and verification and cremation of the dead. The Yangon Division received the initial push of response with the Prime Minister opening an office in order to “provide close supervision and support to the National Natural Disaster Preparedness Central Committee (PNJA 2008).” Normalcy was restored to 33 townships within the Yanogon Division within 4 days through the reinstallation of electricity and water, as well as entire renovations of the hospitals (PNJA 2008). Though the government had begun to restore some areas back to normal, many of the most affected areas were in hard to reach areas due to the surrounding terrain. This presented major problems in identifying the needs and then delivering assistance to those devastated populations (Myanmar Tropical Cyclone Nargis Flash Appeal 2008).

Other problems arose from the beginning of the response as the Emergency Committee was hesitant in allowing access to international humanitarian aid workers. The relief effort was hindered by visa regulations that prevented experts in emergency relief from entering the country as well as keeping those in need from receiving sufficient supplies of humanitarian aid. On May

23, 2008, the United Nations Secretary General met with Myanmar's Senior General Than Shwe and reached an agreement to expedite the visa process in order to allow humanitarian aid workers of all nationalities into the country. The agreement also allowed for multiple logistical hubs to be launched in and around the affected areas for easier access to aid distribution (Myanmar Tropical Cyclone Nargis Flash Appeal 2008).

Realization that the government did not have the national capacity to respond to the extremely devastating damage played a vital role in reaching the agreement which also led to the formulation of a Tripartite Core Group (TCG). The TCG was compilation of high-level representatives of the Government, the Association of Southeast Nations (ASEAN), and the United Nations. This group of representatives coordinates relief efforts while assisting the travel needs of international aid workers and worked to deliver the Post-Nargis Joint Assessment to allow for an in-depth look at the specifics of the storm. As time has passed, greater access to the country has been permitted for individuals of the UN and organizations such as the International Federation of Red Cross and Red Crescent Societies along with many other non-governmental organizations from around the world. Initially, the government would not allow the UN to fly supplies by helicopters to vulnerable populations that were affected by the storm. As of June 2, 2008, the government has rescinded on this decision and allowed for helicopters to be used in order to reach those isolated populations. According to the study by the UN, the helicopters "have since made a marked difference in reaching vulnerable populations in all corners of the Delta (Myanmar Tropical Cyclone Nargis Flash Appeal 2008)."

The Proventionconsortium Forum states that the affects of the cyclone on the country were increased as a result of poor planning and ineffective government. The reason being that vulnerability was increased by turning the mangrove delta ecosystem into an important part of

the national GDP, commercial rice cultivation. This conversion of the delta made populations vulnerable by eliminating a natural buffer and increasing exposure to coastal storms as well as resulting in “persistent poverty and inadequate provision of basic needs (Pelling and Smith 2008).” The forum highlights the lack of disaster risk mitigation due to an “absence of effective local-, regional- and national level- early warning, public shelters and evacuation planning (Pelling and Smith 2008).” Many of these factors led to a highly vulnerable population that was severely impacted by the storm. The article states that a lack of local participation in development decision-making along with limited or no accountability to local populations fuels disaster risk (Pelling and Smith 2008).

The Lessons Learned

The Post-Nargis Joint Assessment highlights the key priorities for managing disaster risk following Cyclone Nargis. Cyclone Nargis uncovered the vulnerability of Myanmar to high-impact, low-frequency natural hazards along with the “need for the country to undertake a range of actions for reducing, mitigating and managing disaster risks in the future to avoid similar catastrophes (PNJA 2008).” The Assessment suggests that loss of life as well as the economic impact of disasters can be reduced through advanced investment and planning in the short, medium, and long terms of disaster risk management. The study gives five key priorities for improved disaster risk management and reduction over the short, medium, and long terms as follows:

- (1) risk identification and assessment;
- (2) strengthening and enhancing emergency preparedness;
- (3) institutional capacity building;
- (4) risk mitigation investments, and;
- (5) risk financing and transfer mechanisms.

Sichuan Earthquake 2008

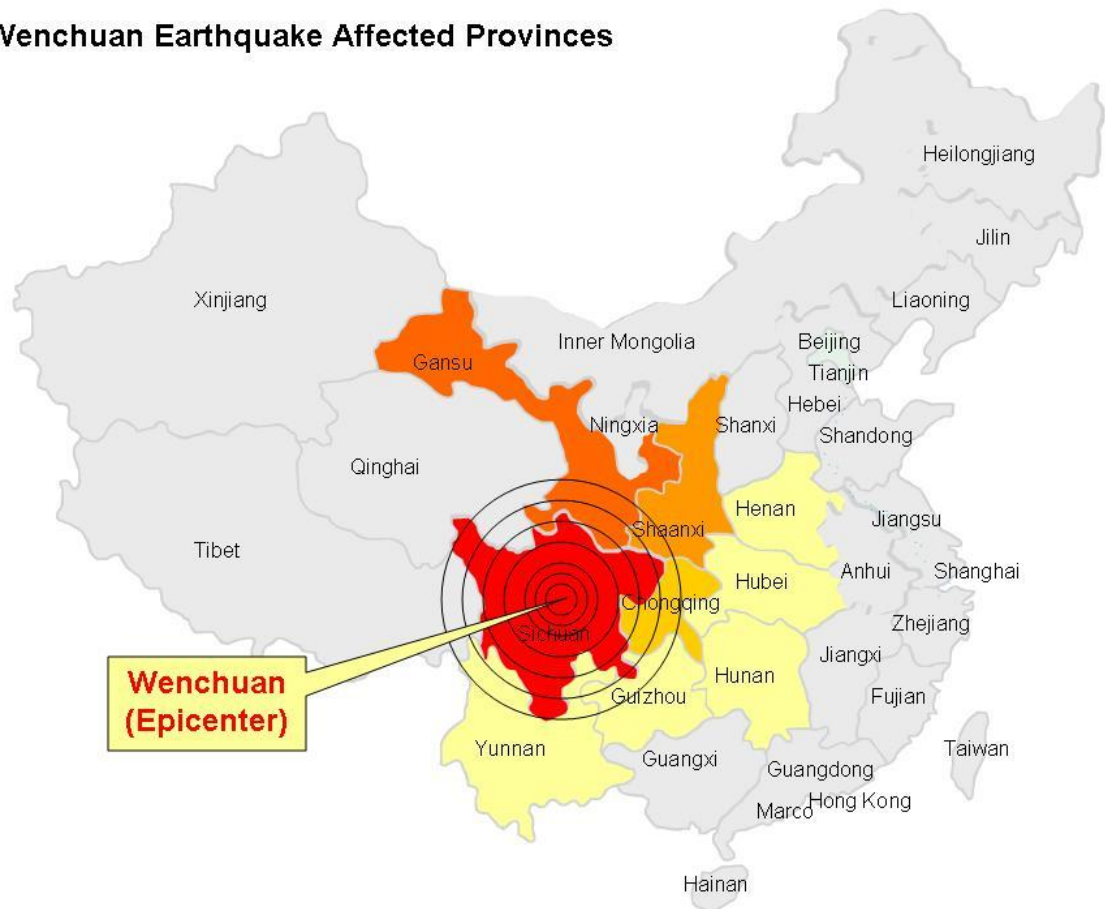
The Earthquake and Impacts

On May 12, 2008, an 8.0 magnitude earthquake shook the southwestern portion of China damaging and destroying some 6.5 million homes while affecting an estimated 46 million people (UN China 2008). The earthquake killed more than 69,000 people and injured over 374,000 more, while leaving over 18,000 people missing. There were more than 15 million people

evacuated from their homes causing an estimated 5 million people to live in temporary shelters. Damage from the earthquake ranged throughout a vast area of provinces with the most substantial impacts being felt within the Sichuan provincial capital of Chengdu. Figure 8 below provides a demonstration of the devastating earthquake and the vast area affected by the disaster.

Figure 8: Map of Areas Affected by the May 12, 2008 Earthquake

Wenchuan Earthquake Affected Provinces



Source: (Wenchuan Earthquake Affected Provinces)

Much of the region's infrastructure was destroyed with the destruction of roads, buildings and water distribution systems. The Sichuan province alone had approximately 7,000 schools destroyed out of a total of 10,000 that were considered severely damaged. There was 29,300 km of water piping damaged with some 34,000 water distribution systems in and around the Sichuan province being completely destroyed. The quake caused serious damage to all natural resources such as land, bodies of water, and vegetation in the affected areas. For example, landslides as a result of the earthquake blockaded rivers resulting in the formation of 34 "quake lakes" throughout the Sichuan province (UN China 2008).

The damage to vegetation greatly impacted farmers of which 5 million lost their harvests. Not only harvests were destroyed, but also the seed stock in which the farmers count on to produce such harvests. The effects splashed over into the job market where over 400,000 people were estimated to have lost their jobs in urban areas due to either the total destruction of businesses or their inability to operate. The earthquake adversely affected the livelihoods of over 30 million people, many of which were farmers. There was extreme damage to the agricultural land, access roads, reservoirs and irrigation systems with the collapse of storage areas leading to a substantial loss of grain. With some 46 million people being affected, almost 6.5 million homes were completely destroyed forcing 5 million people into temporary shelters (UN China 2008).

This year China has allocated 35 billion yuan or \$5.1 billion in order to deal with natural disasters, while establishing a central budget stability fund of 103.2 billion yuan or \$14.8 billion. The government has also stepped up its contributions in recovery efforts by setting aside 70 billion yuan or \$10.1 billion, which is to be added to over the next two years, for reconstruction of the areas affected by the earthquake. The government had also already delivered 10.8 billion

yuan or \$1.6 billion of the 25 billion yuan or \$3.6 billion allotted to relief and rescue efforts (IFRC 2008a).

Table 5: Key Facts and Figures from Sichuan Earthquake

Population affected	46.2 Million
Evacuated	15 Million
Homeless	5 million
Damage	
Buildings damaged	21 million
Buildings destroyed	5 million
Economy	
Estimated loss	US\$ 86 billion

Source: (UN China 2008)

The Problems and Response

Table 5 above demonstrates the total estimated loss numbers in population affected, damages, and economy. According to the UN China Appeal for Early Recovery Support, the Chinese government “was decisive and swift” in their response to the devastating earthquake. Led by China’s President and Premier, the government has put forth a multitude of resources in order to support the relief and recovery efforts of local governments (UN China 2008). The President sent in more than 170,000 army, armed policemen, and paramilitary forces to assist in the rescue effort. More resources sent in by the government of China included “over 120 trucks

for the transportation of water and over 370 sets of small-scale water treatment systems bought with foreign and domestic aid” to go along with 1.5 million tents, 4.8 million blankets, and 14 million sets of clothing that were dispatched by the Ministry of Civil Affairs (UN China 2008). Purified water was made available by the Army to many of the worst impacted areas with 17 mobilized water treatment systems mounted on trucks. Along with contributing to those resources necessary for human survival, “the Government of China quickly mobilized national financial resources to meet the needs of the affected population (UN China 2008).”

The article “World News: China’s Rebuilding Effort Takes on Breakneck Pace; Nation Mobilizes To Repair Damage, Resettle Thousands,” looks at China’s centralized, authoritarian government which was able to rapidly rebuild because it could mobilize physical and financial resources across the large nation. In the case of the devastating earthquake in the Sichuan province, the disaster zone covered about 50,000 square miles—an area larger than the entire state of Indiana. Approximately 7.8 million homes were completely destroyed with 23.4 million suffering damages (Batson 2008).

Following the earthquake, the government made a decision to set aside \$10 billion in rebuilding for this year alone and got to work. There was no delaying the process by “dickering over budgets and lines of responsibility,” as was the case with New Orleans after Hurricane Katrina (Batson 2008). In the city of Dujiangyan, the government focused the rebuilding plan on two things: getting the homeless back into their homes and sustaining the tourism industry, since it was the city’s largest source of income. The city government brought in architects and planners from all over the world to assist the country’s own resources in the rebuilding process. Obviously, mistakes are more than likely going to be made in such a rushed project, but head of the city planning bureau, Mr. Qu, established a clear objective to settle the people as soon as

possible and help industries recover without incurring large-scale mistakes. Therefore, improvements to any small mistakes that were made can be corrected after the objective is complete. Creativity is also a key in the rebuilding process where two-thirds of the factories will have to be moved before being able to restart operations (Batson 2008).

The government responded in a swift manner according to the Chinese state run Xinhua news agency as the Prime Minister ordered roads to be cleared of mudslides and other damage caused by the earthquake. Clearance of these roads would then increase the information flow from the epicenter region allowing for a more effective response by the government. The Prime Minister also ordered the military to air-lift medical and food supplies to the region of devastation (Thousands killed as earthquake hits Tibetan areas 2008). Although many reports regarding the relief effort put forth by the Chinese government are positive, questions have still been raised about the failures of the government to properly regulate construction. According to the Proventionconsortium forum, the government's "failure to regulate construction resulted in the deaths of many children as schools and residential buildings collapsed." The result was the collapse of an estimated 7,000 classrooms killing some 19,065 students and causing billions of dollars in damages. The government has begun investigations into the reasons for the extremely large number of building collapses (Pelling and Smith 2008).

The Ministry of Foreign Affairs immediately contacted the UN following the earthquake in order to express "its hope to have the support of the international community in rehabilitation and reconstruction efforts (UN China 2008)." An agreement between the UN and the Chinese government brought about a plan to assist with the reconstruction plan as well as the medium and longer term plan for recovery. Plans for assistance emphasize support for the local economic and social recovery by focusing on key sectors in order to help citizens rebuild and recover from the

losses endured. Along with the priority areas that continuously need additional response, the plan will provide assistance to nine key sectors including livelihoods; shelter; water, hygiene and sanitation; health, nutrition and HIV and AIDS; education; protection of vulnerable groups; environment; ethnic minorities; and coordination and communication. The table 6 below shows the summary of budget requirements by sector in US dollars (UN China 2008).

Table 6: Sector Budget Requirements

Sector	US Dollars
Livelihoods	7,500,000
Shelter	2,935,545
Water, Hygiene and Sanitation	3,314,860
Health, Nutrition and HIV and AIDS	6,308,720
Education	2,500,900
Protection of Vulnerable Groups	3,174,316
Environment	1,469,110
	3,301,325
	1,000,000
Ethnic Minorities	1,572,190
Coordination and Communication	396,970
<i>Estimated Total</i>	<i>33,473,936</i>

Source: (UN China 2008)

The initial estimate of \$33 million for the UN China Appeal for Early Recovery Support outlines the beginning to the mid-to-long term assistance program by the UN. A subsequent package to aid the longer term reconstruction effort will follow upon determination and identification of needs by the Government of China. Substantial resources have been set aside by international governments, companies, foundations, and individuals in response to the

catastrophe with the United Nations Office for the Coordination of Humanitarian Affairs reporting some \$230 million being raised to this point. There was also \$8 million dollars given by the UN from the UN Central Emergency Response Fund in order to contribute to life-saving relief efforts. Other agencies have contributed to the relief effort, such as the International Federation of Red Cross and Red Crescent (IFRC) which “launched a revised US\$93 million emergency appeal on 30 May covering life-saving relief support and the implementation of reconstruction programs for a period of 36 months (UN China 2008).”

In an article published by BBC News, Paul Danahar compares the response of the government of Myanmar (Burma) following the Cyclone Nargis to that of the government of China’s response and recovery efforts after the Sichuan Earthquake. Danahar reported from both locations immediately following the disasters and reports first-hand the details of his experiences. The reporter describes “the stench of death” as the difference between the two places. He experienced the Chinese government rapidly working to provide relief and rehabilitation following the earthquake when he states that “five days into the earthquake in China, the trucks of aid and relief supplies were too many to count.” The same could not be said for the government of Myanmar as he recalled “at the same stage in Burma I counted only two.” The eyewitness account compares the reaction and response or lack thereof by the military regime in Burma to the Chinese reaction to a devastating earthquake 32 years earlier with the government being “under-resourced and overwhelmed by the natural calamity (Danahar 2008).”

The Current Situation

The economic impacts of the earthquake on the Chinese economy have yet to be seen as the country attempts to rebuild the devastated Sichuan province. With only 1 percent of China's population living in the hardest-hit area, which accounted for an even smaller portion of the country's economic output, impacts are projected to be minimal on the overall economy. This comes as the result of many of the people affected being impoverished farmers, and the fact that the economic activity lost will be basically offset by the activity created by the reconstruction efforts.

Inflation is a large concern for the country government, which had inflation in June around 9 percent. The increase in spending to help rebuild the devastated region is driving up prices for goods. The Chinese government has made plans to slow the growth rate on government spending in other areas in order to offset spending on the relief effort and limit the broader effect on inflation.

Indonesian Tsunami 2004

The Disaster and Impacts

On December 26, 2004, an earthquake with a magnitude of 9.0 on the Richter scale rocked an area near the west coast of northern Sumatra, Indonesia. This "megathrust" earthquake in the Indian Ocean is the fourth largest in the world since 1900 and caused "one of the worst natural disasters in modern times (Athukorala and Resosudarmo 2006)." The earthquake resulted in a displacement of the ocean floor of approximately 5 meters or 16 feet and led to the creation of large tsunamis, which pummeled at least 12 surrounding countries within

just hours. The tsunami began speeding through the ocean at a speed up to 800 km an hour with an initial energy release estimated to be about the same as 25 Hiroshima bombs. Wave heights grew to approximately 24.4 meters in its approach to the Aceh province of Sumatra in 28 minutes (Athukorala and Resosudarmo 2006).

Devastation soon followed the massive waves as there was no warning system in place in the Indian Ocean to notify those countries in the direct path of the tsunami. The countries along the Indian Ocean also lacked effective civil defense mechanisms in order to distribute information to the people about the approaching danger (Athukorala and Resosudarmo 2006). Although exact figures will probably never be known, to date more than 200,000 people were killed with around 1.5 million others being displaced from their homes. The tsunami affected a total of 12 countries, but caused severe damage to five countries in particular: Indonesia, India, Maldives, Sri Lanka, and Thailand. Figure 9 below demonstrates the epicenter of the earthquake and the spread of the countries impacted by the waves that soon followed the initial shake.

Figure 9: Map of Tsunami Affected Areas



Source: (Colgate Tsunami Relief Project 2006)

Table 7: Summary of Devastation felt from Tsunami

	Areas affected	Damage	Displaced	Deaths	Missing people
India	2200 km of coastal land; 300m to 3 km inland and 3 million people	897 villages, 157,393 dwelling units, 11,827 ha of cropped area, US\$1.56bn assets	647,556	10872	5551
Indonesia	Aceh, 14 out of 21 districts; 1 million people	172 sub-districts, 1550 villages, and 21659 houses	811409	166,760	127,749
Malaysia	North West states of Penang and Kedah		8000	68	6
Maldives	20 attols	100000 people	10578	82	26
Myanmar	23 villages	592 houses of 17 villages	2591	At least 2500*	---
Sri Lanka	1720km of coastal land; 300m to 3. km inland, 103 families.	78,529 fully damaged houses; 41097 partly damaged houses	502668	30959	5644
Thailand	6 provinces on the west coast	6.85m baht have been provided to assist victims	---	5392	3100
Somalia	Puntland region worst hit, 650 km coast line	600 families have lost properties. 2600 fishing boats destroyed	4000	At least 150	NA

Source: (Athukorala and Resosudarmo 2006)

The table 7 above shows estimated data and descriptions of the damage and destruction witnessed in eight of the countries that were most adversely affected by the waves. In financial terms, losses from the tsunami have mounted to over US\$7 billion with Indonesia experiencing the worst of the disaster. Therefore, Indonesia had the largest losses as it was the country closest to the initial earthquake. The country had a total estimate of US\$4.45 billion in damages and losses of which 66% was made up of damages while 34% came from the loss of income flows to the economy. The largest impact in Indonesia was on the private sector at 78% of total damages

and losses with the housing, commerce, agriculture, fisheries, and transport vehicles and services all being severely affected. This sector witnessed total damages and losses of US\$2.8 billion or 63% of total damages and losses (Athukorala and Resosudarmo 2006).

The results of continuous coastal development have been witnessed in recent years by the extreme losses caused by natural disasters such as the 2004 tsunami. While hazard-prone areas continue to be developed and inhabited in developing countries like Indonesia, mitigation measures such as insurance remain a foreign concept. With total material losses reaching approximately US\$10 billion throughout Southeast Asia, there were less than US\$1 billion in insured losses. There is also a lack of alternative risk transfer programs in these developing countries due in large part to the absence of mature insurance markets which is usually required. The complexity of the alternative risk programs and the transaction costs associated with these programs also pose grave problems in establishing such mitigation measures in developing economies (Smolka 2006).

The lack of insurance throughout the impacted region helped to settle the global financial market as the Western and Asian financial services were limited in exposure. Business confidence was also maintained within the region with the incredible generosity displayed through unprecedented amounts of aid pledged to the impacted area. Some 78 countries along with 30 organizations and individual donors pledged \$6.3 billion towards the disaster relief effort. Direct private contributions have been estimated to equal more than \$1.6 billion equaling around \$8 billion in total official aid pledges. The estimated \$8 billion was donated to cover the approximate 5 million people that were directly affected by the disaster. Contributions per head equaled almost \$1000 compared to the average of \$40 per head in previous international fund raising attempts (Athukorala and Resosudarmo 2006).

Hagiwara and Sugiyarto (2005) discuss the poverty impacts of the 2004 tsunami on the five most severely affected countries of India, Indonesia, Maldives, Sri Lanka, and Thailand. The study uses three categories of statistics in order to make an assessment on the poverty impact of the disaster. Hagiwara and Sugiyarto observe the vulnerability of the poor to disaster risk with poorly constructed houses in higher risk disaster zones. Poor countries have limited resources and social power which also increase vulnerability. Costs of disaster recovery are higher in developing countries than those in developed countries as a result of these countries not having the technology to detect disasters, the means to warn citizens or the resources to evacuate a large amount of people. The authors look at the response to the disaster and its management.

Hagiwara and Sugiyarto find that the majority of economic impacts as a result of the tsunami are felt immensely at the local and community levels with limited effects being felt at the national levels. India's agriculture and fisheries were the worst economic activities affected with the impacts coming from the leveling of fields and destruction of irrigation systems along with destroyed or lost boats. The overall impact of the tsunami in India appears to be severe locally with no significant affects, other than additional public expenditures, on the national level. The province of Aceh in Indonesia was the hardest hit with approximately two thirds of the province considered badly damaged. Estimations are that Indonesia's overall economy should remain intact since only about 2% of the country's GDP comes from the Aceh province. The greater effects on Indonesia will be the enormous death toll that the country witnessed with more than 110,000 people losing their lives. Maldives was a country that experienced a low number of lives lost, but the most damage to its economy with almost 53% of its GDP being directly affected. The tsunami severely damaged the country's major infrastructure by paralyzing many sectors such as tourism, housing, fisheries and water and sanitation. The

financial impacts on the GDP of various countries impacted by the tsunami can be seen in table 8 below.

Table 8: Financial Impact of Tsunami

Country	Estimated Total Financial Loss (% of GDP)	GDP Growth Forecast for 2005 (%)	
		Post – Tsunami	Pre – Tsunami
India	0.3	6.0	6.8
Indonesia	2.3	5.2	5.5
Maldives	53.1	5.0	1.0
Sri Lanka	5.2	5.5	5.2
Thailand	0.8	6.6	5.6

Source: (Smolka 2006)

Smolka (2006) finds that there were vast differences in the impacts on the national economies of each country directly affected by the tsunami. Countries that are significantly dependent on the tourism and fishing industries, such as the Maldives and Sri Lanka, experienced the worst economic effects as a result of those industries being severely disrupted. Indonesia, which experienced a substantial death toll, only witnessed minor effects on their economy along with Thailand and India. The author suggests that even though there were a significant number of deaths associated with the tsunami, the financial impact of the disaster on a global scale and even some national economies was fairly insignificant. The storm did raise awareness and present the question of preparedness to the majority of coastal communities around the world. This has helped to better inform people all over the world about the possibility of such disasters occurring in their country. The tsunami has raised awareness which is the first

step in identifying hazards. Once these hazards have been identified, the risks must be evaluated and potential losses have to be controlled, prevented and mitigated as effectively as possible.

Indonesia saw the most devastating damage due to the country's proximity to the original shock of the earthquake. Interestingly enough, the damage was less severe along the west and east coast of the Aceh province as a result of an ecosystem that has remained in relatively good shape. The same could not be said for other coastal cities that were affected more than other areas because the ecosystem had been disturbed by housing, tourism and destructive fishing. Aceh witnessed an estimated \$4.5 billion in damages and losses which equates to almost 100 percent of the province's GDP in 2003. Out of the \$4.5 billion, 60 percent were made up of damages with 40 percent constituting losses from income flows lost to the economy. The private sector bared witness to the majority of total damages and losses at 78 percent with the public sector seeing the other 22 percent. A large portion of the damages and losses from the private sector consisted of the estimated 115,000 houses destroyed along with another 150,000 severely damaged. The public sector losses came as a result of one-third of the road network, schools and hospitals being destroyed by the waves (Athukorala and Resosudarmo 2006). Table 9 below shows the estimated damages as a percentage of pre-disaster levels.

Table 9: Estimated Damages as Percentage of Pre-disaster Levels

Items	Damages in Percentage
Road	31.7
School	30.0
Hospital	33.3
Health Centre	24.0
Permanent House	26.9
Non-Permanent House	30.4
Irrigated Paddy Field	24.9
Non-irrigated Paddy Field	32.4
Estate Crop	27.9
Community Forest	28.3
Non-Oil/Gas Industry	27.4

Source: (Athukorala and Resosudarmo 2006)

The devastated province of Aceh had a GDP in 2003 of \$4.5 billion, which accounted for about 2.3 percent of Indonesia's total economy. The oil and gas industry is the region's largest sector as it contributed 43 percent to the regional economy. Fortunately for both the regional and national economies, the oil and gas industry escaped the disaster practically unscathed. The largest impact on the region's economy was a result of the extreme damage to the agriculture sector. The sector that comprised 32.2 percent of the regional GDP was most adversely affected with a high number of casualties and destroyed capital (Athukorala and Resosudarmo 2006).

In the agriculture sector of Aceh, the fishing industry was struck the hardest with reports of around 55,000 fisherman and aquaculture workers losing their lives and some 14,000 others still missing. Those fisherman and aquaculture workers that were spared by the earthquake and tsunami bore witness to extreme damage and destruction to the majority of necessities for the industry. Reports revealed serious damage to some 40-60 percent of coastal aquaculture ponds

as well as 36-48 thousand ha of brackish water aquaculture ponds that contained an abundance of shrimp and milkfish. The approximate 9,500 units of small scale fishing fleets consisting of canoes, with inboard motor and with outboard motor, in Aceh prior to the tsunami were reduced by 65-70 percent by the disaster (Athukorala and Resosudarmo 2006).

The agriculture sector also had large initial damage estimates of rice fields with about 10 percent of the total area under rice cultivation or 30,000 ha in Aceh being badly affected with soil salinity problems. Recovery was quick to the soil in this area due to humid conditions in the region which cleaned the affected soil through rainfall and irrigation. As a result of the rapid recovery, the planting was scheduled to resume in April and May of 2005 with only 9,000 ha failing to recover for farming. Table 10 below shows the estimated damages and losses in Indonesia following the tsunami (Athukorala and Resosudarmo 2006).

Table 10: Estimated Damages and Losses in Indonesia

	Total Impact			Property	
	Damage	Losses	Total	Private	Public
Social Sectors	1674.9	65.8	1740.7	1440.6	300.1
Housing	1398.3	38.8	1437.1	1408.4	28.7
Education	110.8	17.6	128.4	9	119.4
Health	82.5	9.4	91.9	23.2	68.6
Culture and Religion	83.4		83.4		83.4
Infrastructure	636	240.8	876.8	325.9	550.8
Transport	390.5	145.4	535.9	165.8	370.1
Communications	18.9	2.9	21.8	8.6	13.2
Energy	67.8	0.1	67.9	1.1	66.9
Water and Sanitation	26.6	3.2	29.8	18.3	11.4
Flood control, irrigation and sea protection works	132.1	89.1	221.2	132.1	89.1
Productive Sectors	351.9	830.2	1182.1	1132	50.1
Agriculture and Livestock	83.9	140.9	224.8	194.7	29.9
Fisheries	101.5	409.4	510.9	508.5	2.5
Enterprises	166.6	280	446.6	428.9	17.7
Cross Sectoral	257.6	394.4	652	562.9	89.1
Environment	154.5		154.5	548.9	
Governance and administration	89.1		89.1		89.1
Bank and Finance	14		14	14	
Total Impact	2920.4	1531.2	4451.6	3461.4	990.1

Source: (Athukorala and Resosudarmo 2006)

According to the economic growth report developed and distributed by the World Bank and Bank of Indonesia, the area of Aceh has made significant strides toward recovery from the devastating tsunami. These strides have put the economic growth of the region back on track as can be seen by table 11 below which compares the economic growth of Aceh from 2003-07 in the various sectors. The Aceh region has witnessed the recovery of the agriculture sector which expanded by almost 5 percent in 2007. Growth in the agriculture sector has exceeded pre-tsunami agricultural production for the first time as a result of improved security conditions

along with the results of the reconstruction effort that “by December 2007 had allocated about US\$300 million to the agriculture and fisheries sectors (World Bank 2008a).” The growth for the sector stems from the rise in estate crops of over 15 percent since the tsunami, followed by increases in the food crops and fisheries sector. The agriculture sector has grown from 17 percent of Aceh’s economy to 23 percent in 2007 (World Bank 2008a).

Table 11: Economic Growth in Aceh 2003-2007 (%)

Economic growth, 2003-07 (%)					
Sector	2003	2004	2005*	2006**	2007**
Agriculture, Forestry & Fishery	3.2	6.0	-3.9	1.5	4.9
Mining and quarrying	9.8	-24	-22.6	-2.6	-21.6
Oil & Gas	9.9	-24.4	-23.0	-4.3	-22.6
Quarrying	3.6	7.3	0.8	78.8	2.0
Manufacturing Industry	1.6	-17.8	-22.3	-13.2	-10
Oil and gas Industry	1.7	-11.6	-26.2	-17.3	-16.7
Non-oil and gas industry	1.6	-37.3	-5.1	1.1	8.6
Electricity, Gas & Water Supply	16.9	19.5	-2.0	12	23.7
Construction	0.9	0.9	-16.1	48.4	13.9
Trade, Hotels and Restaurants	2.4	-2.6	6.6	7.4	1.7
Transport & Communication	3.8	3.6	14.4	10.9	11
Banking & financial services	30.9	19.4	-9.5	11.7	6
Services	6.3	20.1	9.7	4.4	14.3
GDP	5.5	-9.6	-10.1	1.6	-2.2
GDP w/o oil & gas	3.7	1.8	1.2	7.7	7.4

* = revised figures

**= preliminary figures

Source: BPS

Source: (World Bank 2008a)

The structure of Aceh's economy has shifted dramatically since the tsunami in 2003. The dramatic change has been partially produced by the reconstruction effort, which has contributed to the growth in the services sector up from 26 percent in 2003 to 44 percent of Aceh's economy in 2007. The mining and manufacturing sectors have been diminishing as they are down from 56 percent of the economy in 2003 to 32 percent in 2007. Estimates continue to reveal expected growth in the economy of Aceh in 2008 with reconstruction being a key element in driving that growth (World Bank 2008a).

Policy and Response

The republic government of Indonesia, which has an elected legislature and president, approached the response to the natural disaster in three phases. The first phase was to concentrate on the emergency and rescue operations, then move to rehabilitation of basic socio-economic infrastructure along with law and order, followed by the final phase of rebuilding the economy and governmental system. According to Athukorala and Resosudarmo (2006), "the first phase of crisis management has taken a much longer time in Indonesia compared to Sri Lanka." This was a result of many factors that combined to present the emergency and rescue operations with significant problems. Those factors ranged from the extreme magnitude of the damage and destruction to the infrastructure to the economic and political turmoil being experienced in the region of Aceh. The damage and destruction further ravaged an already poor road network hampering the arrival of relief to the region. A conflict between the Indonesian government and the Free Aceh Movement crippled the information outflow from Aceh to other parts of Indonesia. The disruption in communication resulted in a lapse of at least two days before the actual effects experienced from the tsunami in Aceh were known outside of the region compared to the immediate information made available in other affected countries. The Free

Aceh Movement also limited the role of local government as the Aceh province was in *de facto* control for 18 months prior to the tsunami in hopes to crush the movement (Athukorala and Resosudarmo 2006).

It was not until April 2005 when the second phase of rehabilitation began. The second phase included the rehabilitation of basic socio-economic infrastructure, law, and order. This phase was expected to be completed in around two years with the third phase projected to take another five years. The second phase has been moving along at a slower rate than expected by the government with housing rehabilitation and resettlement of displaced people along with restoration of basic utilities barely beginning by May of 2005. At the same time, recovery of the transportation network of roads and bridges had hardly begun and “90 percent of displaced people were still in rehabilitation camps and/or temporary shelters (Telford and Cosgrave 2007).” The slow start to the second phase came as a result of the central government not developing a strategy to coordinate the resettlement and restoration tasks. International agencies instead, had begun the second phase and the process to help restore the regions infrastructure. Even though capabilities were limited to begin with, local government involvement was even further reduced by the number of casualties and loss of records experienced from the waves. Strides have been made in the reconstruction of houses as the pace accelerated from 1,000 to 5,000 houses rebuilt per month in October 2005. This came as peace was established between the government and the Free Aceh Movement (Telford and Cosgrave 2007).

The development of blueprints needed for the second and third phases are being conducted by the Indonesian National Planning and Development Agency (Bappenas). These phases are expected to be funded in most part by the international community which responded in a historically rapid and generous way following the tsunami. International response to the

catastrophe has contributed US\$13.5 billion to the relief and recovery effort of which US\$5.5 billion came from the general public in developed countries (Telford and Cosgrave 2007).

Indonesia is a part of Asian Development Bank which works with developing member countries in order to provide assistance in cases of natural, technological, and environmental hazards, health emergencies, and country conflict situations. The ADB's Disaster and Emergency Assistance Policy aims to support developing member countries manage disaster risk in order to reduce vulnerability, prevent hazard occurrence, reduce adverse hazard effects, and facilitate rapid ADB response (ADB 2005b). The ADB implemented a new policy in May of 2004, which focused on a systematic approach to disaster management, mainstreaming disaster management, strengthening partnerships, more efficient and effective use of resources and improved organizational arrangements within ADB. This directed the focus of the ADB away from response and to a more proactive approach to reducing losses. The new approach presented the four focal points of prevention and preparation, disaster, emergency response and recovery (ADB 2005a).

A review of ADB's performance during disasters revealed that the response paid little attention to best practices. There was also a lack of training among the ADB staff along with no focal staff for disaster and emergency assistance. Even though the new policy had been implemented prior to the December 2004 tsunami, the key anchor position of the Regional and Sustainable Development Department director was vacant. The RSDD director would have been responsible as the point person for disaster mitigation with regional departments following by identifying their focal points. Without a RSDD director to appoint positions, there was no task force available to coordinate the emergency response following the tsunamis. A RSDD director has since been appointed and changes being made to the Disaster and Emergency Assistance

Policy to add more flexibility to loans provided by the ADB. For more information on the Asian Development Bank and their response to disasters see www.adb.org.

An article published by the Wharton Risk Management and Decision Center (January 2005) titled “In the Tsunami's Wake: How Best to Respond,” gives a background for the response to the 2004 tsunami in Indonesia and problems faced in the effort to respond. Kunreuther suggests that the implementation of a better tsunami warning system would not have made much of a difference in the outcome. This is in part due to the isolation of many villages and the poor telecommunications infrastructure in the region. Multiple problems arose in “getting the last mile” as people are located in remote areas that are hard to reach “even in the best of times (In the Tsunami's Wake: How Best to Respond 2005). Marge Tsitouris, who spent six years as the head of emergency response for CARE, believes that local knowledge is the key to overcoming such distribution problems. She points out that local operation must be directed by professionals that know how to organize and communicate with people to effectively prevent the disaster from spreading (In the Tsunami's Wake: How Best to Respond 2005).

Conclusion

A review of the literature reveals the importance of information flow and communication both before and after the storm. The training of officials and educating the populations facing the risk help to increase awareness. This public awareness will then better prepare an area in the event of a disaster. The government must also look into land-use issues and enforce environmental regulations to preserve coral reefs and mangroves. These natural structures act as buffers to the waves and as evidence shows, could have reduced damages while saving thousands of lives. The tsunami demonstrated how throwing money at the problem does not

guarantee a rapid and efficient recovery. A record amount of donations can only be helpful in a situation where the authorities converge with local communities, governments, and organizations in order to grasp an understanding of local needs and effectively plan and implement reconstruction strategies.

Iowa and Midwest Floods 2008

The Storm and Impacts

More than two weeks of flooding left residents throughout Iowa and the Midwest under incredible amounts of water and duress. Residents in eastern Iowa witnessed rainfall amounts between 15-20 inches in a four week period from May 10-June 10. The floods affected multiple states other than Iowa throughout the Midwest including South Dakota, Minnesota, Wisconsin, Nebraska, Illinois and Indiana as seen below in Figure 10. In all, 24 people were killed as a result of the rising waters with another 148 reported injured. The floods caused some 40,000 people to evacuate their homes as 22 levees were breached (Iowa - Midwest Flood News & Statistics).

Figure 10: Map of Flood Affected Areas



Source: (Iowa - Midwest Flood News & Statistics)

The worst of the affects were felt in Iowa where 9 of the states' rivers crested at record levels. There were a total of 83 out of 99 counties declared disaster areas in the state which saw the Cedar River crest at over 32 feet on June 13—breaking the previous record from 1929. Cedar Rapids was the city hit hardest by torrential rains and flooding with the City Hall, the Linn County jail, the fire department, police communication equipment, most of the public library's collection, and 3,900 homes all being inundated with water. Areas of Cedar Rapids were reported to have flooded beyond the so-called 500-year flood level of 26.5 feet (Iowa - Midwest Flood News & Statistics). The floods not only damaged homes and businesses throughout Iowa and the Midwest, but also destroyed the area's corn and soybean crops causing major financial damage. Iowa bared witness to an estimated 1.3 million acres of corn and two million acres of soybean lost as a result of the floods. The losses, which amount to approximately 20 percent of the state's overall grain crop, range from areas as far north as Mason City and as far south as Burlington all along the Mississippi River. Estimates by Farm Futures revealed that a total of 3.3

million acres of corn have been destroyed across the entire Midwest as a result of flooding (Judge 2008).

In an interview shortly following the floods of the Midwest with a PBS analyst, Gary Thayer, a senior economist with Wachovia discussed the initial economic impacts of the flooding. Thayer spoke of the spike in commodity prices that followed the storm and its potential impact on inflation. The senior economist revealed that corn prices were up about 50 percent for the year before the storm and rose to 80 percent from previous year levels directly after the flooding. With impacts greater than that of the 1993 Midwest flooding, which resulted in a 40 percent increase in corn and a rise in food prices of 3.5 percent the following year, Thayer predicted food inflation to push between 5-6 percent over the next year. This comes as the result of corn's importance and influence in a number of commodities (Thayer 2008).

Vice President of the Environmental Defense Fund's rivers and deltas program, Mary Kelly published the article "Midwest Flooding: When Will We Learn? What we need to do to prevent more disasters like this." Kelly discusses the failures of spending billions of dollars on levees and flood control infrastructure to protect and encourage development of low-lying wetlands. Building levees is costly and gives residents a false sense of security by leading them to believe that they are living "risk-free behind a levee touted as protecting them against a '100-year' or '500-year' storm." Kelly states that the problem is exacerbated by narrow levees that speed up the river along with the loss of wetlands. Especially in the case of the Midwest, the water moves much faster with the levees and increases the amount of damage and danger. The loss of wetlands in the Midwest eliminates those areas which naturally store stormwater and slow runoff to streams and rivers. Kelly proposes five areas in which all levels of government should

focus resources and incentives in order to change the current approach to flood protection and reduce future losses. The changes include:

- Buy-outs of vulnerable lands to decrease the people and property in harm's way
- Returning those lands to forests and wetlands to provide flood buffers
- Reform the taxpayer-funded National Flood Insurance Program to remove incentives for new flood plain development
- Better disclosure of the risks of living in flood plains, even for those lands behind a levee
- Reorienting our approach to flood protection, placing high priority wherever possible on the use of the river's natural floodplain instead of expensive engineered levee and pump systems (Kelly 2008)

Amanda Paulson looks at the impacts the floods may have on small towns in the Midwest. In Oakville, Iowa, which is a town of around 400, only a handful of people were prepared with flood insurance. This was a result of the people in this small town feeling safe because they missed the big "floods in 1993, and they were protected by a so-called 100-year levee (Paulson 2008)." The levee that was supposed to protect against the 100-year flood did not and the town and its people now have to make a decision on whether to stay and rebuild or move elsewhere (Paulson 2008).

Paulson (2008) discusses the difficulties that state and federal policy have in changing the tendency of people rebuilding in areas devastated by disasters. This comes as a result of land-use and building decisions being made at the local level. Experts such as Dennis Milet, a retired sociology professor at the University of Colorado, state that "left to their own volition, people don't perceive risk." The retired professor as well as author of "Disasters by Design" does not

believe that the answer is always to pick up and leave, but rather “to build consistent with risk (Paulson 2008).” This is extremely difficult for small communities to achieve as there is a lack of resources and technical expertise that is needed to build consistent with risk effectively (Paulson 2008).

In the article “U.S. News: Officials Calculating Midwest Flood Cost,” officials commence on a long process of estimating costs as a result of the flood. In response to the catastrophic floods in the Midwest, The Federal Emergency Management Agency “approved more than \$88 billion for temporary housing, home repair and other immediate needs in Wisconsin, Indiana and Iowa (Brat, Barrett and Prior 2008).” Iowa Secretary of Agriculture estimates the state agricultural damage at \$3 billion with one of the hardest hit cities in Iowa, Cedar Rapids, seeing more than \$1.06 billion in land and building damage. The state department of agriculture in Indiana estimates damage at \$800 million in losses in soybeans, corn and winter wheat. The southern half of Wisconsin estimates damages at \$500 million in losses. It is difficult to judge crop damage very early due to the uncertainty of the future success of the current season and the amount of land that will be replanted. “Property damage, lost wages and lost revenue must be balanced against the influx of federal and state disaster funds, as well as spending generated by rebuilding and replacing homes, businesses and furnishings (Brat, Barrett and Prior 2008).” The full economic impact of the floods—which was the result of a rainy spring causing rivers to overflow their banks and levees in some regions—may not be known for months or possibly even years (Brat, Barrett and Prior 2008).

The Response

In discussing the response of the government to the floods across the Midwest, Michael Judge of the Wall Street Journal compared the response to that after Hurricane Katrina with the statement, “unlike Katrina, local, state and federal authorities have, thus far, done an excellent job of coordinating relief efforts (Judge 2008). The Federal Emergency Management Agency learned many lessons from the response to Hurricane Katrina. FEMA promptly set-up an account with a Pepsi bottler in order to provide bottle water for those in Mason City, Iowa after the floodwaters disabled the city’s water treatment plant. At the first sight of flooding, FEMA moved into the region and began handing out assistance. The agency delivered 13 million sandbags to help the levees hold back the floodwaters. They also provided 200 generators and 30 trucks to haul off debris as the rain began falling in early June. FEMA also delivered 3.6 million liters of water and 192,000 ready-to-eat meals throughout the upper Midwest. As of June 23, 2008, FEMA had distributed \$81 million in housing assistance funds in the region. About 45,000 registrations for assistance were received from disaster victims in Iowa, Indiana and Wisconsin alone (Salter 2008).

FEMA has been praised and commended for their response by homeowners and town leaders in the flooded areas as they have quickly dispensed checks for those flooded-out homeowners. The agency also immediately began assessing damage, which is the “key to getting federal disaster declarations that trigger eligibility for assistance, including money to help repair or replace a home.” Officials from both parties praised the proactive approach taken by the agency which began appearing in cities up to a week before rivers crested. Arriving early gave the agency the opportunity to serve as advisers to state and local emergency authorities, helping to reduce overall losses (Salter 2008).

In a letter to the editor of *The Wall Street Journal*, the article titled “Good Planning, Self-Help, Let Iowa Respond Better” compares the response of the government and people after the Iowa floods with that of the response to Hurricane Katrina. Millions of dollars were distributed by the federal government to every state in order to develop emergency responses, “including upgrading and coordinating emergency communications and the agencies involved in emergency response.” The Iowa floods were responded to by implementing an emergency response system which got to work on the disaster immediately. The federal government provides funding to the states because individual states should know where the issues in their area lie and can respond in a much rapid manner to those issues. The state then is supposed to allocate appropriate funds to each local system in order to effectively and efficiently prepare each county or parish for an emergency situation.

CHAPTER 3

HIGHLIGHTS FROM CHAPTER 1

Financial Impacts of Catastrophic Events

- Some studies suggest that economies actually improve with an increase in the GDP growth rate following a disaster. This theory stems from the idea that the random event of a disaster forces the “adoption of improved innovations” and therefore, leads to positive economic growth.
- Short-term declines in the GDP are common following a disaster, but as in Charvériat’s study (2000), there tends to be wide variations in the level of inter-annual fluctuations in GDP.
- Negative long-term impacts on the economy of a country following a disaster are the result of capital assets and other resources being severely damaged.
- There are several ways that natural disasters can “disrupt longer-term investment plans for both physical and human capital.” In order to provide assistance with the relief and rehabilitation process, governments create a diversion of funds and resources away from already planned investments.
- There is no evidence found by Noy (2008) of a correlation between the number killed or affected and the GDP growth, but does observe a “strong indication that the amount of property damage incurred during the disaster is a negative determinant of GDP growth performance.” When measured by the amount of property damage incurred, there is an impact on the macro-economy. Although the amount of property damage has an impact on the macro-economy of a

country, the number of people killed and affected is not found to “present any statistically identifiable evidence of macroeconomic costs (Noy 2008).”

- Skidmore and Toya conclude that this positive partial correlation is a result of the opportunities that disasters provide countries to update capital stock as well as invest in and adapt new technologies.
- Kunreuther and Michel-Kerjan suggest giving incentives such as premium reductions and rate credits to those that invest in the risk-reducing measures.

Impact on Emerging/Developing Economies Highlights

- Catastrophic events create high costs in hazard-prone countries that result in unwanted financial pressure on the government’s mitigation and preparedness projects. Benson and Clay (2004) find that these hazard-prone countries are often made up of poorer nations that are unable to deal with the extra burden on the government. According to the World Bank in 2000, natural disaster losses in developing countries are 20% greater than in industrial countries as a proportion of GDP (Varangis, Skees and Barnett 2002). The large portion of GDP being affected is a result of dependence among many developing economies on agricultural success, which is directly affected by catastrophic weather events (Varangis, Skees and Barnett 2002).
- Developing countries suffer much larger economic losses in comparison with their GDP than developed countries due to limitations in their capacity to reduce risk (DFID 2005).

- Developing countries contain all of the characteristics which increase their vulnerability to such catastrophes.
- Even small-scale disasters present developing countries with a multitude of macroeconomic impacts in various ways, such as physical damage directly to the country's infrastructure, and damage to productive capital and stocks. Impacts are also felt indirectly, presenting long-term problems such as affects on growth, productivity and macroeconomic performance.
- The briefing points out that many of the funds that are diverted by governments and donors to provide disaster relief and rehabilitation are taken away from development programs.
- Noy (2008) finds that much larger shocks occur to the macro-economies of developing countries than events of "similar relative magnitude" in developed countries.
- There are also found to be larger indirect impacts on economic activity in these developing countries for reasons that have not yet been precisely determined.
- It is discovered that a country with higher literacy rates, better institutions, higher per capita incomes, larger governments, and higher degree of openness to trade seem to be able to hold up through the initial disaster shock as well as keep its effects from further causing damage to the country's macro-economy.
- Countries that are able to remain stable and endure shocks without bearing witness to harmful effects on GDP growth rates following natural disasters were found to have less-open capital accounts, more foreign exchange reserves, and higher levels of domestic credit.

- Freeman et. al (2003) find that these poorer countries “can improve their ability to absorb the cost of natural disaster events if they incorporate an analysis of the chronic economic impact of catastrophes into their planning process.”
- Therefore, in order to plan for long-term development, a vulnerable country must recognize its natural disaster exposure as well as the impacts that a catastrophic event may have on the country.
- Kunreuther and Linnerooth-Bayer (2003) find that governmental response in emerging and transitioning countries have a large financial impact on investors around the world. This is due to the inability of residents of these countries to take preventative measures, such as, insurance in order to hedge against catastrophic risk.
- Hedging instruments may be of great importance in the recovery of poor countries from natural disasters that cause catastrophic damage. These hedging instruments or *ex ante* risk transfer mechanisms can come in the form of insurance for the government where the government is financially protected by paying a premium, or capital-market based securities where the interest is paid as protection against catastrophic events.
- The authors find that the public and private sectors must work together in order to reduce future losses from natural disasters and simultaneously limit government assistance. Well-enforced building codes, land-use regulations tied with insurance protection, and economic incentives in the form of long-term loans and subsidies are all proposed as solutions to preventing large-scale disaster relief.

- Developing countries have the ability to effectively prepare for disaster, but as Margaret Arnold of the World Bank's Hazard Management Unit states, "poor countries tend to think of investments in disaster prevention and preparedness as luxuries that they can't afford." This is not necessarily the case as studies have demonstrated that focusing on disaster preparedness instead of solely recovery can be more cost-effective.
- The main conclusion of Skidmore and Toya is that income is not the only important measurement of development in reducing deaths and damages/GDP. The authors reveal that "higher educational attainment, greater openness, a well-developed financial sector, and smaller government are also important."
- Barnett, Skees, and Varngis (2002) also find that aid should not be used to stimulate new economic activity in areas that are highly vulnerable to natural disasters as the next disaster will cause more losses and suffering. The article suggests that a balance should be established between government disaster assistance and private risk management in order to keep from crowding-out each other. The authors conclude that the balance should begin with "segmenting and layering risks" in order to allow for government aid to cover the most catastrophic risk while private market mechanisms are left to handle the lesser of the catastrophic risk.
- Krimgold and Vatsa (2000) also elude to the fact that high population growth in these developing countries combine with poverty, as well as continuing urbanization lead officials to make poor decisions about the use of land. People are housed in disaster-prone areas, but at the same time there is a lack of

emergency services and infrastructure within these areas to cope with catastrophes.

- The following criteria impede on peoples' ability "to protect their livelihood and their relationship with state or other social and political structures on which the people make claims for protection (Aysan 1993)":
 - Lack of resources (material/economic vulnerability)
 - Disintegration of social patterns (social vulnerability)
 - Degradation of environment and inability to protect it (ecological vulnerability)
 - Lack of strong national and local institutional structures (organizational vulnerability)

Reducing Catastrophic Losses through Mitigation Measures

- The majority of studies find that people do not believe disasters will happen to them. Even after the occurrence of multiple disasters people tend to forget the impacts of the storm and therefore will not take the appropriate mitigation measures.
- The idea of the natural disaster syndrome is where individuals living in hazard-prone areas do not take advantage of cost effective loss reduction measures voluntarily.
- Andersen (2002) finds a need for encouragement of prevention and mitigation efforts in order to reduce vulnerability to natural disasters. These prevention and mitigation efforts consist of many measures, but specifically urban planning, enforced building codes, titling of properties, and emergency contingency plans.

- Kleindorfer and Kunreuther find that public-private partnership programs are necessary in order to encourage the use of mitigation measures. This conclusion arises from an examination of three types of public-private partnership programs: building codes, premium reductions linked with long-term loans for mitigation and insurers offering lower deductibles for those investing in mitigation.
- The underlying findings in Kunreuther's study call for "changes in state regulatory involvement, premiums reflecting risk, adherence to building codes, and a means to provide affordable insurance coverage to residents of hazard-prone areas who have financial need" in order to minimize future losses (Kunreuther et al. 2008).
- Significant reductions in future disaster losses can be obtained through constructing old and new homes with better designed structures. Individuals generally underestimate the risk and seem to only focus on their short-term financial situation in overlooking cost-effective mitigation.
- According to Smolka, in order to reduce losses, states should design and enforce land use and building regulations, secure the serviceability of critical facilities and infrastructure, develop and coordinate emergency plans that specifically define the responsibilities of all authorities involved.
- The authors find that private insurance is a catalyst for reducing losses, but do not discount the importance of active involvement by the public sector.
- A study done by the Wharton Business School's risk management center concluded that residences built to wind-resistance standards developed since 1996 had a 60% lower claim frequency than those built before 1996. Thus the better

mitigated homes experienced less costs and destruction. It was then hypothesized that mitigation strategies would reduce the damage of a 100-year hurricane in Florida by 61%.

- In summarizing the effects that building codes had on reducing losses during Hurricane Charley, the study found that “the enforcement of modern engineering design based building codes made a positive impact on the performance of residential homes (IBHS 2007).”
- There are new risk transfer and contingent funding instruments, such as layered reinsurance contracts, risk-linked securities, catastrophe risk swaps, and contingent surplus notes, which have been developed to modify the risk management profile of countries. The integration of all such elements into a country’s risk management strategy will provide complementary solutions.
- CAT Bonds, swaps and weather derivatives must not be used in competition with reinsurance as they provide additional capacity for top-rank losses. The majority of alternative risk transfer programs have only been introduced in highly developed countries due to factors such as the complexity of the programs, transaction costs, and the requirement of mature insurance markets (Smolka 2006).

Impacts of Governmental Policies

- Kunreuther et. al (2008) finds that “state governments play a critical role in establishing building codes and assuring these standards are effectively implemented.” Studies by the Insurance Information Institute following the

devastating Hurricane Andrew in 1992 suggest that building code compliance and enforcement could have reduced insured's losses by 25 percent.

- State governments have control over land-use and can prevent construction in areas that are consistently battered by natural hazards (Kunreuther et. al 2008). Construction in these areas should only be allowed with restriction of federal funding following a catastrophe to those who choose to take on the risks of an area highly exposed to specific natural hazards.
- Low-interest loans, grants and tax benefits are available from the federal government to those individuals or small businesses that are not insured or are underinsured. The same federal relief is also made available to those cities and local governments in need of financial assistance. Special assistance is given to states upon declaration of a "major disaster" by the President.
- This has become a concern for governments as they are faced with the financing of disaster relief, reconstruction, and rehabilitation. Governments must make allocations for relief and reconstruction efforts following disasters which results in a negative impact on the countries' macroeconomic stability.
- Local governments are given little incentive to invest in protective measures and therefore do not, because of the fact that the federal government in the United States will cover the losses from catastrophic events. The federal government will fund at least 75 percent of the costs associated with rebuilding and repairing public facilities due to natural disasters. In the case of a natural disaster that results in a catastrophic event, the federal government will fund 100 percent of the costs (Kovacs and Kunreuther, 2001).

- The federal government of Canada has set up the Disaster Financial Assistance Agreement. This agreement makes public relief unavailable to those property owners that do not take advantage of and invest in affordable and available private insurance.
- The “moral hazard” is caused by federal and local governments coming to the aid of disaster victims and therefore resulting in no consequences for their decision to rebuild or go without insurance.
- Burby et. al (1999) find that there has been a failure to plan and manage the local land use in order to reduce risks. Instead, the government has subsidized development and movement to risky areas.
- Burby (2006) the federal government increases losses by trying to make hazardous areas safer, as well as local officials not paying adequate attention to policies that limit vulnerability. The author suggests that local governments can minimize catastrophic losses through comprehensive planning that pays attention to hazard mitigation by increasing incentives.
- Kydland and Prescott (1977) find that discretionary policy does not always result in socially optimal policy in the long run even though it may be most advantageous in the current situation.
- Kunreuther (2001) suggests legislation be changed so that recovery funds are not made available to those local governments which failed to implement the measures. The author gives an alternative form of insurance that the government could take which is a community-based form of insurance. Here the government

covers losses to public structures by levying property taxes on all residents of the community.

- Hagiwara and Sugiyarto (2005) suggest that governments should speed up recovery by committing to sound macroeconomic management. This is due to the negative effect that a longer recovery time has on a developing nation's economy. The Indonesian government set up an independent authority called the Specific Authority Board for Aceh Reconstruction in Indonesia which enabled better implementation of programs allowing for a faster recovery. Independent authorities, such as the one in Indonesia, deliver assistance with the use of recovery funds to developing nations. A key component in the recovery process is the contributions of local governments as they are able to prioritize programs that are most needed. On the local level, needs can be better identified and presented with more specificity to help generate employment and regain a community's infrastructure.
- There can be synergies built between policies and programs which reduce disaster risk and at the same time support development efforts (Hagiwara and Sugiyarto 2005).
- Microcredit programs are another way to achieve two objectives at once by contributing sustainable livelihoods for the poor as well as help those same people back on their feet following a catastrophe (Hagiwara and Sugiyarto 2005).
- Krimgold and Vatsa (2000) conclude that in order to achieve effective risk management governments and communities must be strengthened with

knowledge of hazard mitigation alternatives as well as the implementation of mitigation measures.

- State governments have the power in the establishment and implementation of building codes.

Impacts of Outside Organizations

- The 2004 briefing by the Department for International Development reports that although outside organizations undoubtedly save many lives and relieve suffering all around the world, humanitarian programs may have negative impacts on the long-term resilience of developing countries following a disaster.
- An important part in the recovery of a nation following a catastrophe is not only short-term strategy that many outside organizations focus on, but also the long-term needs in sustaining lives and restoring livelihoods (DFID 2005).
- A study by Benson and Twigg (2004) finds that aid agencies currently use many tools that could actually be used by countries in order to assess disaster risk. These analyses can then be used in order to measure the social, environmental, humanitarian, and financial costs and benefits of implementing various mitigation measures.

Role of Data

- Data from natural disasters is vital in the reduction of future losses as it can be used not only for research, but for “analytical tools to help prioritize international action to reduce disaster risk (IFRC 2005).”
- A common problem with data collecting in all four of the international databases is that standard definitions that are needed to effectively organize the data are

lacking. Disaster data has greatly improved over the last 20 years as the World Disasters Report 2005 points out, but there are still numerous challenges such as defining hazards and distinguishing events, the absence of standard guidelines for local disaster data and public accessibility to the data (IFRC 2005).

CHAPTER 4

CONCLUDING REMARKS

A large quantity of literature on catastrophic risks and mitigation measures around the world was reviewed in order to form a compilation of the most cost-effective and efficient ways to reduce extreme losses, both domestically and internationally. With recent catastrophic events as a result of weather-related disasters, serious issues have come to the forefront on the ever-increasing costs of such natural disasters. Policies and strategies must be reviewed and revamped along with mitigation measures around the world in order to better cope with the rise in costs. While overall death tolls from those disasters have been on the decline, the number of disasters and people affected has been on a steady increase from 1975-2007. The key to reducing losses essentially becomes the ability of governments and outside organizations to work together in order to better educate people on the risks at hand and therefore, lowering the level of vulnerability.

While negative impacts on the economy are more often seen in the short-term, severe damage of resources and capital assets may lead to a negative long-term impact. Catastrophic events create a diversion away from the original long-term investment plans of physical and human capital. Already planned investments are forgone as governments redirect funds and resources in order to provide assistance with the relief and rehabilitation process.

On the contrary, studies have also shown that in some situations a disaster has the ability to lead to positive economic growth. The positive economic growth comes from the improvement of infrastructure and the “adoption of improved innovations,” which are forced to happen following extreme damage to a region. Natural disasters give countries the opportunity to upgrade capital stock as well as invest in and adapt new technologies that would have

otherwise been rejected. These investments and upgrades to technologies and facilities have the potential to increase a country's productivity resulting in economic growth rather than decline.

According to the reviewed literature, natural disasters have a greater impact on those countries that have highly vulnerable populations. Therefore, the key for reducing costs associated with catastrophic events is to reduce the level of vulnerability of a particular population. Prior research reveals that developing countries tend to be more adversely affected than those countries that are developed due to their higher level of vulnerability. The higher vulnerability to disasters comes as a result of developing countries not being able to see the full benefit of mitigation measures and therefore, not investing in those measures that could potentially reduce costs.

The governments of developing countries are limited in their capacity to reduce risk and therefore, suffer much larger economic losses in comparison with their GDP than developed countries. The large portion of GDP being affected is, in many cases, the result of dependence among many developing economies on agricultural success, which is directly affected by catastrophic weather events. Studies reveal that a country with higher literacy rates, better institutions, higher per capita incomes, larger governments, and higher degree of openness to trade seem to be able to hold up through the initial disaster shock as well as keep its effects from further causing damage to the country's macro-economy. Countries that are able to remain stable and endure shocks without bearing witness to harmful effects on GDP growth rates following natural disasters were found to have less-open capital accounts, more foreign exchange reserves, and higher levels of domestic credit.

Even small-scale disasters present developing countries with a multitude of macroeconomic impacts in various ways, such as physical damage directly to the country's

infrastructure, and damage to productive capital and stocks. Impacts are also felt indirectly, presenting long-term problems such as affects on growth, productivity and macroeconomic performance. Studies have not yet determined however, the reasons behind the larger indirect impacts on economic activity that developing countries face.

Land-use issues also arise in developing countries and often lead officials to make poor decisions due to a combination of high population growth and poverty to go along with continuing urbanization. In such instances, people are housed in disaster-prone areas even with the lack of emergency services and infrastructure within these areas to cope with catastrophes. Many developing nations neglect to invest in disaster prevention and preparedness measures on the principle that such mechanisms are luxuries that they cannot simply afford. This is not the case as a nation can improve its ability to absorb the cost by recognizing the natural disaster exposure as well as the impacts that a catastrophic event may have on the country, and incorporating an analysis of the possible economic impacts an event could have into the planning process. In order to plan for long-term development, developing nations must turn the focus to disaster preparedness instead of solely recovery as studies have shown this to be more cost-effective.

As studies show, people do not believe that disasters will happen to them. Once a disaster has occurred, there is a tendency of people to forget the impacts and thus not implement the appropriate mitigation measures. Encouragement of urban planning, enforced building codes, titling of properties, and emergency contingency plans should help to reinforce the benefits of mitigation measures and potentially reduce losses. Public-private partnership programs can be formed in order to assist with reinforcing the importance of implementing mitigation measures and to allow for incentives for those who participate in such measures.

Some complementary solutions for integration into a country's risk management profile are new risk transfer and contingent funding instruments, such as layered reinsurance contracts, risk-linked securities, catastrophe risk swaps, and contingent surplus notes. The majority of these programs are typically only designed for highly developed countries with mature insurance market.

Domestically, states have the ability to establish and implement land-use restrictions and building codes. Therefore, states must assure the effective implementation of these requirements in order to help reduce losses. Since local governments have control over land-use and can prevent construction in hazardous areas, construction in these areas should only be allowed with restriction of federal funding following a catastrophe to those who choose to take on the risks associated with an area highly exposed to specific natural hazards. Both federal and local governments come to the aid of disaster victims resulting in no consequences for the decision to rebuild or go without insurance; thus making mitigation useless.

The government currently increases losses by trying to make hazardous areas safer and discarding policies that limit vulnerability. Losses can be minimized by planning that pays attention to hazard mitigation by increasing incentives. Along with afore mentioned land-use issues and building codes, implications for the international community include creating programs such as having a Country Risk Officer that takes care of managing risks, sets priorities of risks, and upstarts the government's ability to take preventative actions before disaster occurs. There is also a need to form a coalition between governments and corporations to more easily communicate and minimize the threat against international risks.

Outside organizations play an important role throughout the process of disaster risk management. These organizations must work alongside government officials in keeping not

only the short-term, but the long-term needs of the country in mind as well. Aid agencies currently use analytical tools in order to assess disaster risk that would prove beneficial to governments in order to measure the social, environmental, humanitarian, and financial costs and benefits of implementing various mitigation measures. Collaboration between aid agencies and governments to provide a country use to such tools could allow for a reduction in future losses.

Data plays an important role in the reduction of future losses from natural disasters. It can be used not only for research that will provide further insight into ways to reduce costs, but also for analytical tools that reduce disaster risk by prioritizing international action. There are currently four major international databases that have greatly improved disaster data in recent years, but still face many challenges such as defining hazards and distinguishing events, the absence of standard guidelines for local disaster data and public accessibility to the data.

Further research is suggested to be done on the cost-benefits that mitigation measures have on both developed and developing economies. There are various theories on the reasons that mitigation measures are not always implemented by individuals and governments, but with further research in this area, they would more than likely be null and void if individuals and governments were able to see the cost-benefit of implementing various mitigation measures. There are very few studies that focus extensively on the *ex post* impact that natural disasters have on the macro-economy. Even though indirect impacts on economic activity in developing countries have been found to be larger, the reasons for this greater impact have not been determined and warrant additional research.

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